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167707

FIVE-YEAR REVIEW REPORT

Second Five-Year Review Report

For

Arrowhead Refinery Site

Hermantown

St. Louis County, Minnesota

September, 2002

PREPARED BY

Minnesota Pollution Control Agency
St. Paul and Duluth, Minnesota

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Minnesota Pollution Control Agency

Date: 9/26/02

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Superfund Division
U.S. EPA, Region 5

Date: 9/30/02

FIVE-YEAR REVIEW REPORT

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Attachments

List of Acronyms

AIC	Adult Intake Concentration
ARAG	Arrowhead Remedial Action Group, the later PRP group in the mixed settlement Consent Decree
ARAR	Applicable or Relevant and Appropriate Requirement
AROD	Amended Record of Decision
ATSDR	Agency for Toxic Substances and Disease Registry
BaP	Benzo(a)pyrene
Barr	Barr Engineering Company
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
City	City of Hermantown
cPAH	Carcinogenic Polynuclear Aromatic Hydrocarbon
CW	City Well
DOC	Dissolved Organic Carbon
DRO	Diesel Range Organics
EPA	United States Environmental Protection Agency
FDI	Field Design Investigation
FS	Feasibility Study
FY	Fiscal Year
GAC	Granular Activated Carbon
GC	Gas Chromatograph
GC/MS	Gas Chromatograph / Mass Spectrophotometer
gpm	Gallons per minute
GRO	Gasoline Range Organics
GW	Ground water
HBV	Health Based Value
HQ	Hazard Quotient
HRC	Hydrogen Release Compound
HRL	Health Risk Limit
HRS	Hazard Ranking System
IRIS	Integrated Risk Information System
LTRA	Long Term Response Action
MASC	Minnesota Arrowhead Site Committee, an early PRP group
MCLs	Maximum Contaminant Levels
MDH	Minnesota Department of Health
mgd	Million Gallons per Day
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Liter
MN	Minnesota
MNDOT	Minnesota Department of Transportation
MPCA	Minnesota Pollution Control Agency
MW	Monitoring Well
NCP	National Contingency Plan

NPL	National Priority List
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PAHs	Polynuclear Aromatic Hydrocarbons
PLP	Permanent List of Priorities
ppb	parts per billion
ppm	parts per million
PRPs	Potentially Responsible Parties
PVOCs	Petroleum Volatile Organic Compounds
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RAL	Recommended Allowable Limit
RAOs	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act of 1976
RD	Remedial Design
RI	Remedial Investigation
ROD	Record of Decision
RW	Recovery Well
SARA	Superfund Amendments and Reauthorization Act of 1986
SDWA	Safe Drinking Water Act
Site	Arrowhead Refinery Co. Site
SPM	State Project Manager
SQT	Sediment Quality Target
SRV	Soil Reference Value
STW	Short-Term Worker
SVES	Soil Vapor Extraction System
SVOCs	Semi-Volatile Organic Compounds
TAO	U.S. EPA Technical Assistance Office
TBC	To Be Considered (potential ARAR)
TCLP	Toxicity Characteristic Leaching Procedure
ug/L	Micrograms per Liter
VOC	Volatile Organic Compound
WLSSD	Western Lake Superior Sanitary District

Executive Summary

The implemented remedy for the Arrowhead Refinery Company Superfund site (Site) in Hermantown, Minnesota included several media: source materials, soils and sediments, and ground water.

The source materials remedial action consisted of:

◊ excavation of about 7,025.8 tons (the 1994 AROD estimated 4,600 cubic yards) of sludge and filter cake from the lagoon and soils using a visually contaminated standard;
◊ treatment of 7,025.8 tons by chemical disassociation, yielding 1,105,349 gallons of off-spec fuel;
◊ disposal of 5,334 cu yd of hazardous debris in a permitted Resource Conservation and Recovery Act (RCRA) Subtitle D facility; and
◊ disposal of 843 tons of non-hazardous debris.

The soils and sediments remedial action consisted of:

◊ dewatering and pretreatment of ground water to facilitate excavation, route to the French Drain system, then to the local waste water treatment plant for treatment;
◊ excavation of visually contaminated soils and sediments;
◊ confirmatory sampling to verify the cleanup level of 500 parts per million (ppm) lead;
◊ lead stabilization of soils and sediments;
◊ disposal of 24,327 tons of treated soils and sediments in a permitted RCRA Subtitle D facility;
◊ backfill into the excavated area with clean soil and topsoil, seeding, to elevations preventing ponding; wetland plants specified in the AROD were replaced with upland vegetation;
◊ implementation of an air quality monitoring plan and actions to protect health of nearby residents;
◊ temporary relocation of one sensitive population resident.

The ground water remedial action consisted of:

◊ a water main extension and 13 residential and business connections for those at risk;
◊ abandonment of 13 individual drinking water wells at risk;
◊ a ground water extraction and treatment system, constructed as a French Drain routed to the local treatment plant for treatment, to capture and restore the aquifer and to prevent off-site migration of contamination; and
◊ operation and maintenance of the ground water extraction and treatment system until ground water at the Site perimeter meets Maximum Concentration Levels (MCLs);

The Site remedy also includes implementation of institutional controls. The city of Hermantown has zoned the area as restricted commercial/industrial. Restrictions on the Site have been drafted and will be implemented to ensure that the Site remains used for restricted commercial/industrial development only.

The Site achieved construction completion for the ground water, source areas, and the soils and sediments remedial actions with the signing of the Preliminary Close Out Report on December 19, 1996.

The trigger for this five-year review was the completion of the first five-year review. The assessment of the first five-year review in 1997 found that the ground water remedy was constructed in accordance with the requirements of the AROD and is functioning as designed. It also found that immediate threats are addressed and the remedy is expected to be protective when ground water cleanup goals are achieved through the pump and treat system. The first five-year review did not address the source materials and soils and sediment phases.

The source materials remedy is protective of human health and the environment because the threats presented by this media have been addressed through excavation, treatment and disposal off-site in a permitted RCRA Subtitle D facility.

A protectiveness determination of the soils and sediments phase remedy at the Site cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions:

1. Evaluate potential impacts to aquatic organisms caused by lead in sediments of the "EPA" ditch south of the former Gopher Oil Building and downstream of it exceeding the Tier 2 Sediment Quality Target (SQT) of 130 mg/kg;
2. Evaluate and, if necessary, bring the settled areas on the Site to final grade and establish a surface water drainage plan, including addressing the plugged culvert north of Highway 53 and downstream of the Site. The plugged culvert north of Highway 53 should be addressed after resolving the potential impacts to aquatic organisms caused by lead in sediments of the EPA ditch; and
3. Finalize and file the deed restrictions.

It is expected that these actions will be completed by December 2004, at which time a protectiveness determination will be made.

The Site ground water remedy is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled. At present:

- contaminated ground water is being contained on-site;
- there are no current receptors; and
- the ground water is being discharged to the Western Lake Superior Sanitary District (WLSSD) sanitary sewer within the volumes and discharge quality that is required under the WLSSD permit agreement.

This five-year review anticipates four to eight more years of operation and maintenance to meet MCLs in the ground water at the Site perimeter.

Although the property is zoned properly, the institutional control for Site deed restrictions needs to be completed.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION

Site name (from WasteLAN): Arrowhead Refinery Company

EPA ID (from WasteLAN): MND98082397

Region: 5 **State:** Minnesota **City/County:** Hermantown, St. Louis County

SITE STATUS

National Priority List (NPL) status: Final Deleted Other (specify)

Remediation status (choose all that apply): Under Construction Operating Complete

Multiple Phases? Yes No **Construction Completion date:** 12/19/96

Has site been put into reuse? YES NO

REVIEW STATUS

Lead agency: EPA State Tribe Other Federal Agency

Author names: Maureen Johnson/Barbara Gnabasik

Author titles: Project Manager/Project Hydrogeologist **Authors' affiliation:** Minnesota Pollution Control Agency (MPCA)

Review period: 09/30/97 to 08/30/02

Date(s) of site inspection: 8/6/02

Type of review: Post-Superfund Amendments and Reauthorization Act of 1986 (SARA)

Pre-SARA NPL – Removal Only

Non-NPL Remedial Action Site NPL State-Tribe-Lead

Regional Discretion

Review number: 1 (first) 2 (second) 3(third) Other (specify)_____

Triggering action:

Actual Remedial Action (RA) Onsite Construction at Phase # _____ Actual RA Start at Phase # _____

Construction Completion Previous Five-Year Review Report

Other (specify) _____

Triggering action date (from WasteLAN): 9/20/97 (First Five-Year Review Complete)

Due date (five years after triggering action date): 09/20/02

* ("Phase" refers to operable unit.)
** (Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.)

Five-Year Review Summary Form (continued)

Issues:

1. The Consent Decree, restrictions and access agreements were not completed and filed pursuant to Consent Decree in 1995. Draft restrictions need to be finalized by MPCA and filed at the St. Louis County Recorder's Office as a restrictive covenant. Action needs to be taken on remaining issues 2 and 3, stated below, so that the restrictions can be finalized.
2. Settlement and changes in drainage are occurring.
3. The potential exists for aquatic organisms to be affected by the lead in sediments of the EPA ditch south of the former Gopher Oil Building, now HOM warehouse, and downstream of it to the culvert on the north side of Highway 53.
4. No confirmatory sampling was conducted at on-site wells after the 1996 excavation, treatment and disposal of source materials and soils and sediments which contained arsenic, hexavalent chromium, vanadium, zinc, and 4-methylphenol; 4-methylphenol has a new more restrictive Minnesota Department of Health (MDH) Health Risk Limit (HRL) of 3 ug/L.
5. The current lead analysis method does not determine whether dissolved lead is moving with ground water.
6. 1,4-dioxane, a compound recently recognized to be closely associated with trichloroethene, has a new MDH Health Based Value (HBV) of 30 ug/L. Trichloroethene is a contaminant of concern at the Site and 1,4-dioxane has not been sampled for previously at the Site.

Recommendations and Follow-Up Actions

1. The Consent Decree, restrictions and access agreements were not completed and filed at the St. Louis County Recorder's Office pursuant to Consent Decree. Because St. Louis County had difficulty locating a certified copy, assure the Consent Decree is filed. Assure access is provided to MPCA, determine which parcel(s) need the restrictions, finalize restrictions, and file the restrictive covenant.

2. Settled areas may need to be brought up to final grade and some drainage issues may need to be resolved through development and implementation of a drainage plan. Conduct a Site survey to determine settlements that need correction, prepare a drainage plan for the Site, bring the settled areas to final grade, as necessary, and evaluate the cause of plugging of the culvert and repair, as necessary.

3. The potential exists for aquatic organisms to be affected by the lead exceeding the Tier 2 SQT of 130 mg/kg in sediments of the EPA ditch south of the former Gopher Oil Building, now HOM warehouse, and downstream of it to the culvert on the north side of Highway 53. Perform additional sediment sampling in this area to determine current contaminant levels.

4. Perform confirmatory sampling for arsenic, hexavalent chromium, zinc, vanadium. The sampling locations are well MPCA-4A and the extraction system discharge, also collect ground water samples for zinc from well MPCA-14S, and 4-methylphenol (SVOCs) from wells MPCA-4A, MPCA-5A, MW-3S, MW-14A, and the extraction system discharge. Compare results with the current standards and numbers.

5. Sporadic total lead in the extraction system discharge exceeds the 15 micrograms per liter (ug/L) at the tap number, which may indicate migration with ground water, or, as commonly happens, less mobile lead particulates inadvertently get into the sample bottles prior to preservation. Collect four quarters of dissolved, in addition to total lead discharge data from wells MPCA-4A, MPCA-5A, MW-14S, MW-3S, and the discharge.

6. Sample and analyze ground water for 1,4-dioxane from source area (on-site) wells and the discharge to determine if any concentrations exceed the HBV of 30 ug/L. Given that trichloroethene is only found in very low concentrations that do not exceed the 5 ug/L cleanup level at the Site, detection of 1,4-dioxane is not expected above the 30 ug/L HBV.

Protectiveness Statements:

Source Materials Phase

The source materials remedy is protective of human health and the environment because the threats presented by this media have been addressed through excavation, treatment and disposal off-site in a permitted RCRA Subtitle D facility.

Soil and Sediment Phase

A protectiveness determination of the soils and sediments phase remedy at the Site cannot be made at this time until further information is obtained. However, in the short-term, the removal of the contaminated soils and sediment and the current land use are protective of human health. Further information will be obtained by taking the following actions:

- Resolve whether potential impacts to aquatic organisms are occurring due to lead in sediments of the EPA ditch south of the Gopher Oil Building and downstream of it to the culvert exceeding the lead Tier 2 SQT of 130 mg/kg.
- Bring the settled areas on the Site to final grade and establishing a surface water and sediment management plan, including addressing the plugged culvert north of Highway 53 and downstream of the Site after addressing with potential impacts to aquatic organisms are occurring as discussed above.
- Finalize and file the deed restrictions.

It is expected that these actions will be completed by December 2004, at which time a protectiveness determination will be made.

Ground Water Phase

The ground water remedy at the Site is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.

At present:

- contaminated ground water is being contained on-site;
- there are no current receptors; and
- the ground water is being discharged to WLSSD sanitary sewer within the volumes and discharge quality that is required under the WLSSD permit agreement.

Long-term Protectiveness

The source materials remedy has been completed and should remain protective. The ground water phase should also remain protective since contaminated ground water is being contained on-site and cleanup levels should be attained within the next 4 to 8 years. For the soil and sediment phase, protectiveness should be achieved after the recommendations above have been implemented. The current schedule to complete these recommendations is December 2004.

Other Comments:

None

Arrowhead Refinery Company Superfund Site
Hermantown, Minnesota
Second Five-Year Review Report

I. Introduction

The purpose of the five-year review is to determine whether the remedy at the Arrowhead Refinery Superfund Site (Site) is protective of human health and the environment. As required, the methods, findings, and conclusions of the review are documented in this five-year review report. In addition, the five-year review report identifies issues found during the review and recommendations to address them. The report addresses all remedial action phases of the Site and the Site as a whole.

The MPCA, as delegated by the EPA, is preparing this five-year review pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) § 1211 and the National Contingency Plan (NCP). CERCLA § 121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section (104) or (106), the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The EPA interpreted this requirement further in the NCP; 40 Code of Federal Regulations (CFR) § 300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

The MPCA conducted the second five-year review of the remedy and remedial actions implemented at the Site in Hermantown, Minnesota. This review was conducted by the State Project Manager (SPM) and State Hydrogeologist for the entire Site from October 1997 through September 2002. This report documents the results of the review and the inspection conducted by the MPCA staff. EPA delegated and funded the work through a cooperative agreement.

The first Five Year Review was conducted by in 1997. This is the second statutory five-year review for the Site. The triggering action for this review is the date of the previous Five Year Review, which was September 20, 1997.

The statutory review is conducted because the hazardous substances, pollutants or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure. Because the first five-year review covered only the ground water remedial action, this second five-year review addresses all media phases and the Site as a whole.

Site Chronology

Table 1: Chronology of Site Events by Date

Initial discovery of problem or contamination: MPCA letter requiring improvement in waste disposal		1967
Pre-NPL MPCA order to discontinue disposal of wastes on the property		1976
Pre-NPL EPA at MPCA request investigated environmental effects		1979
Pre-NPL EPA found violation of Clean Water Act		1980
Pre-NPL EPA constructs ditch to divert surface water, fence		1980
EPA demand letter to Arrowhead Co. to clean up Site, divert surface water runoff from Site	June	1980
CERCLA Section 106 Unilateral Administrative Orders to construct water main and ground water pump and treat system	March	1980
Pre-NPL sampling 1981 to 1983		1981
NPL listing	October	1983
MPCA Permanent List of Priorities (PLP) listing	October	1984
Cooperative Agreement signature, for Management Assistance Subsequent Cooperative Agreement Amendments	September 29, Multiple	1984
Remedial Investigation/Feasibility Study (RI/FS) complete		1986
Public Health Assessment in RI/FS		1986
Record of Decision (ROD) EPA signature	September 30,	1986
Remedial design start, Site pre-design field investigations, technology reviews, tests	March 31,	1987
CERCLA Section 107 Suit, US District Court for costs	July	1989
CERCLA Section 122(e) Special Notice letters to conduct the source material remedy	May	1990
RD start Water main and connections		1990
RD start Ground water extraction and treatment system	March	1990
Actual remedial action start	August 15,	1990
RD complete Water main and connections	December 31,	1990
Construction start Water main and connections	August 15,	1990
RD complete Ground water extraction and treatment system	May	1990

Site Chronology, continued

Construction start Ground water extraction and treatment system	May,	1990
Construction complete Water main and connections	December 31,	1990
CERCLA Section 106 Unilateral Administrative Orders to conduct the source material remedy	May	1991
RD start Source Materials	September 6,	1991
RD start Contaminated Soils and Sediments	September 6,	1991
Long Term Response Action, begin	July 30,	1993
Construction complete Ground water extraction and treatment system	June 4,	1993
RD start Contaminated Soils and Sediments		1994
ROD Amendment EPA and MPCA signatures	February 9,	1994
RD complete Source Materials	January 10,	1995
Most recent Cooperative Agreement Amendment, for LTRA	February 14,	1995
Consent Decree	May 24,	1995
Construction start Source Materials	April 20,	1995
Most Recent Amended Superfund State Contract signature	July 22,	1996
Construction start Contaminated Soils and Sediments	January 25,	1996
Construction complete Contaminated Soils and Sediments	November 27,	1996
Construction complete Source Materials	December 31,	1996
Construction completion (Preliminary Close Out Report) date	December 19,	1996
First Five-Year Review	September	1997
Force Main ownership transfer from MPCA to WLSSD	March 25,	1999
Purchase of tax-forfeit parcels of the Site for redevelopment	February 26,	2002

III. Background

Physical Characteristics

The Site is located in T50N R15W, Section 4 in the east one-half of the southeast one-quarter, Hermantown, St. Louis County, Minnesota, eight miles northwest of the city of Duluth. The map in Attachment 1 is the map contained in the Consent Decree and it shows the legal descriptions. Of the approximately 50 acres designated as the Site, about ten acres of concern on the Site are adjacent to the major State Highway 53 in Parcels B, B1, and B2. The map also shows county parcel numbers.

The original Site facilities were constructed in a white cedar swamp that was filled in when needed. The adjacent wetlands are ecologically sensitive with no known endangered species at or near the Site. The surface water formerly flowed southwest over the Site and discharged via a culvert under Highway 53 to a marshy area that joins Rocky Run Creek, a tributary of the Midway River. The Midway River ultimately discharges into the St. Louis River, which empties into Lake Superior. Minnesota has specific rules and policies for Lake Superior and its watershed, governing nondegradation, water quality criteria, and implementation procedures in support of federal Great Lakes laws and international agreements.

The Site area of concern, where the sources were located before cleanup, is currently surrounded on all sides by ditches to divert surface water around the area of concern. A ditch, constructed by the EPA Emergency Response Team and Bay West, Inc., begins at about the center of the northern line of the area of concern and directs flow eastward, south down the Lavaque Bypass Road ditch on the east of the Site, and then west down the State Highway 53 ditch through the culvert under the Highway 53 and into wetlands south of the highway. A county ditch on the western side runs through wetlands on the west and southwest edges of the Site and drains south through the same culvert.

The Site is rural, with rural residences, commercial development over time, with more populated areas within a few miles.

Land and Resource Use

The Site is on a major state highway, a good location for commercial development. The current and projected zoning and land use for the Site is restricted commercial/industrial. The land uses for the areas surrounding the Site are residential on the south and east sides of the Site, and restricted commercial/industrial on the Site and to the north. Future land use on the Site is expected to remain the same as at present, with increasing commercial development along the highway over time.

The Site use has been industrial/commercial since prior to 1945, with re-refining of used oil from 1945 until 1977. The Site soils have been cleaned up to a restricted commercial/industrial level and covered with top soil. An existing building is now used as a warehouse.

Ground water in the shallow outwash aquifer, commonly used for drinking water wells in the county, is currently used by three residences east of the Site on the opposite side of Lavaque Bypass Road. Other residences and businesses near the Site have been connected to municipal water. Surface water use is ultimately governed by its final destination, Lake Superior, a protected water for multiple uses including drinking water and recreation.

History of Contamination

The Site was used for re-tinning milk cans prior to 1945. The Site also may have been used as a dump and there may have been a gas station somewhere on the Site at one time. No further information is available regarding the re-tinning business, the dump, or the gas station except that the dump was located south of the lagoon.

From 1945 to 1961, the property was used for recycling waste oil part-time. Arrowhead Refining Co. re-refined oil full-time until February 1977. The heavily contaminated areas were the two-acre sludge lagoon which together with the source materials total about 4600 cubic yards and the process area with contaminated soil which, together with contaminated sediments in the wastewater ditch, totaled 27,327 tons. See the Source Material Section of Question A in the Technical Assessment for further discussion of the re-refining process.

The Site is located along Highway 53 and is visually obvious. The contamination with volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PAHs), and heavy metals raised concerns for the safety of private drinking water wells in the area, direct contact and ingestion exposure, and environmental damage.

Initial Response Pre-Record of Decision

In 1967 the MPCA staff sent a letter to Arrowhead Refining Company requiring improvements in waste disposal at the Site. The MPCA staff initiated a Site investigation in April 1976. After a 1976 MPCA order to discontinue dumping of sludge and clean up the Site, the Arrowhead Refinery Co. terminated operations in early 1977 with a declaration that they had no money for cleanup. From 1979 to 1984, the MPCA and the EPA investigated the extent, nature, and magnitude of contamination as well as identifying potential and actual impacts to receptors. Reports in 1979 and 1980 narrowed the extent of the contamination to the current ten acres of concern.

In 1980, the EPA determined that discharge from the Site violated provisions of the Clean Water Act. The EPA, through its contractor, Bay West, Inc., dug a ditch on the north, east and south sides of the Site so that drainage and run-off was diverted around the drainage lagoon and facilities area. The ditch directed flow from the north side of the Site to the east, south along Lavaque Bypass Road, and then west along the ditch of Highway 53. The ditch ended at a culvert on the north side of Highway 53. The Site was also fenced in 1980.

Residential wells within a half-mile of the Site were sampled in 1981, 1982, and 1984 with no detections except one low-level hit of chloroform. The EPA believed that the chloroform detection was not Site-related.

The Site was included on the National Priorities List (NPL) in October 1983 with a score of 43.75, and on the state Permanent List of Priorities in October 1984.

The remedial investigation (RI) report and feasibility study (FS) were completed in 1986. A public health assessment was completed in 1986. The EPA signed the ROD for the Site on September 30, 1986.

Basis for Taking Action

The media that were contaminated included soils, sediments and ground water. The 1986 RI Report included a public health evaluation. RA was required for the ground water, soil, sediments and sludge for the following reasons:

- The acid sludge lagoon was a PAHs, VOCs, and heavy metals (primarily lead) source for future soil and water releases and possible air releases, as well as a direct contact threat for acid burns and contaminant exposure, and it was causing obvious environmental damage including trapping birds and animals in the tarry substance;
- Leaching of contaminants to ground water caused drinking water standards and criteria to be exceeded. Specifically, carcinogenic PAHs in some ground water samples exceeded the 10^{-6} excess lifetime cancer risk. Concentrations of some noncarcinogens including cadmium, lead, and manganese also posed risks.
- Soil exposure resulted in excess lifetime cancer risks for both commercial and residential use. Estimated intakes of some noncarcinogens (e.g. lead, cadmium, xylene, and barium) exceeded the acceptable intake levels;
- Potential impacts to downgradient offsite private wells might have occurred through contaminated ground water migrating across the Arrowhead Refinery Company property boundary and Highway 53. Estimated arrival times to two private wells south of Highway 53 was between 15 and 40 years. Future use of these private wells may have posed risks in excess of 10^{-4} lifetime cancer risks.

IV. Remedial Actions

At the Site, there are three phases which some Site documents term as operable units, but these phases were not identified as operable units in EPA's database: the source material phase, the contaminated soils and sediments phase and the ground water phase.

Remedy Selection

Remedial Action Objectives

In 1990 the MPCA staff's Response Action Plan itemized the following RAOs:

1. Reduce releases of pollutants or contaminants or hazardous substances from the sludge lagoon, soils, peat and sediments at the Site into the ground water and/or surface waters of the State.
2. Reduce public health and environmental threats posed by the sludge lagoon at the Site due to direct contact through touch or ingestion.
3. Reduce public health and environmental threats posed by the ingestion, inhalation, absorption, and migration of the pollutants or contaminants or hazardous substances contained in the sludge, soils, peat and sediments at the Site.
4. Reduce concentrations of pollutants or contaminants or hazardous substances from the ground water and surface water beneath, at or adjacent to the Site.

On September 30, 1986, EPA signed a ROD for the Site. The ROD specified:

- excavation and thermal treatment of sludge, oil saturated peat, filter cake, with leachate and air emissions control, and disposal of ash on-site if non-hazardous;
- excavation and thermal treatment of contaminated soil and sediments which exceed the 10^{-6} excess lifetime cancer risk level and adult chronic acceptable intake Adult Intake Concentration (AIC) levels, and disposal of ash on-site if non-hazardous;
- extraction and treatment of contaminated ground water, with a French Drain and extraction wells at 45 gallons per minute (gpm), and with treatment either on-site or off-site without pretreatment to WLSSD sanitary sewer;
- construction of ground water monitoring wells and implementation of a long-term ground water monitoring program;
- extension of municipal water supply water main and connections to potential receptors, and no further use of private wells by these residents; and
- design investigations.

MPCA concurred with the 1986 ROD with the provision that other alternatives be evaluated during the design investigations. This evaluation occurred in several design studies, and in 1994, EPA issued a ROD amendment (AROD) that explained the fundamental remedy change for the source material phase and the contaminated soils and sediments phase to:

- Excavation of sludge and filter cake using a visually contaminated standard with an estimated volume of 4,600 to 6,100 cubic yards;

- On-site treatment of sludge and filter cake by chemical disassociation (re-refining) of the toxic compounds within the sludge/filter cake matrix to produce a saleable off-specification fuel and to recover lead in a smelting operation or to stabilize and place in a permitted RCRA Subtitle D facility; and
- Excavation of visually contaminated soils and sediments, treatment by stabilization of lead, followed by placement in a permitted RCRA Subtitle D facility.

The ground water remedy did not change in the 1994 AROD. However, the cleanup levels were changed from 10-6 cleanup levels to MCLs, and the compliance point was determined to be the Site perimeter as measured by the extraction system discharge.

Remedy Implementation

Source Material Areas and Soils and Sediments Phases

A Fieldwork Design Investigation (FDI) was completed by EPA's contractor, CH2M Hill. The report submitted on May 1, 1990 indicated additional contaminated soils were discovered. After more fieldwork, the final estimate of contaminated soil was set at 27,000 cubic yards.

Because of the major increase of contaminated soil discovered in the Remedial Design, several additional treatability studies were conducted to find a less expensive alternative to incineration, as specified in the 1986 ROD. The treatability studies included:

- A solvent extraction treatability study for the source material and contaminated soils by CH2M Hill on behalf of EPA;
- A bench scale biotreatability study conducted by the MPCA staff; The biotreatability study found that the organic contamination in the Site soils may be treated through a slurry phase process; and
- A solid waste composting process study conducted by the Minnesota Arrowhead Site Committee (MASC), the group of potentially responsible parties (PRPs) at the Site. The study was successful for destroying VOCs and 3-and 4-ringed noncarcinogenic PAHs in soil and source material. It was questionable if the 5- and 6-ringed PAHs would be remediated. Other problems identified included being less successful at bioremediating the source material, a substantial increase in volume, and liberation of lead found in the oily matrix.

While the remedies listed above proved not to be viable, it did lead to the discovery that carcinogenic PAH samples were all beneath detection limits and the cleanup level specified in the 1994 AROD.

In 1992, MPCA staff conducted a soil washing and lead removal treatability study. This technology also did not prove to be viable. Since organics no longer were of concern, EPA and MPCA staff agreed to amend the soil remedy from on-site incineration to placement in a Subtitle D landfill. MPCA staff also stated a preference for treatment remedy prior to disposal.

In late 1992 through early 1993, MASC explored using thermal treatment pursuant to the original remedy for the source material. This alternative also was unsatisfactory.

In spring 1993, MASC discovered a proprietary reprocessing / re-refining technology developed and managed by 7&7, Inc. In spring 1993, the EPA conducted a treatability study and demonstrated that this technology worked well for the source material. The reprocessing/re-refining technology employed by 7&7, Inc. involves liquification, flocculation, separation, and filtration. Lead and other metals in the source material are separated out leaving a low lead content off-specification fuel. Lead-rich filter cakes are recovered for use or stabilized and placed in a landfill.

Based on the results summarized above, the remedy was modified in the 1994 AROD by the EPA to be the 7&7, Inc. excavation and rerefining/ re-processing described above. As a result of court action, the potential responsible parties and EPA signed a Consent Decree regarding implementation of the AROD in 1995. MPCA also participated in the negotiations and concurred.

Documentation of completion of the source material and soil and sediment excavation, treatment and disposal response actions are found in the reports:

"*Completion of Remedial Action Report, Completion of Work Report for the Arrowhead Refinery Site, December 23, 1996*" by 7-7, Inc. and SERVICE Environmental Engineering, and

"*Phase 1 Residuals, Phase II Contaminated Soils And Sediments, Remedial Action Closure Report, Arrowhead Refinery Site, Hermantown, Minnesota, November 1996*" by CH2M Hill (EPA's contractor).

Remediation of the source materials, soil and sediment and ground water are discussed below.

Source Material, Phase I

The Arrowhead Refinery Assessment Group (ARAG), successor to the MASC group of PRPs, was formed to be the response group in the mixed-funding settlement in the judicial Consent Decree. ARAG conducted the source material remedy. The Arrowhead Refinery re-refined oil by extracting moisture and impurities. The re-refining process consisted of using an acid-clay process. Three waste streams were produced: an acidic sludge that contained metals and was disposed in a wetland that became a sludge lagoon; a filter cake that was disposed over the native peat in the wetland so additional processing area was created; and waste water that was discharged to the wastewater ditch. The contractor, 7-7, Inc. was hired by to excavate the sludge, filter cake, and oil-saturated peat and re-refine the oil. The sludge was black with a tar-like consistency and it consisted of wastes derived from the treatment of the waste oil with sulfuric acid. The filter cake consisted of clay saturated with oil. Originally, it had accumulated on the plates of the filter press.

The February 1994 AROD specifically required that all visibly contaminated source material be excavated, liquified, neutralized, and homogenized with dilutant and neutralizing agents on-site in the areas of the sludge lagoon, the process area, and the wastewater ditch. The material was then to be conditioned with a precipitating agent, clarified, and the decant liquid was to be offered for sale as off-spec fuel. The solids were to be filtered and dried to stabilization and off-site Subtitle D landfill disposal.

Changes to these required actions occurred on February 9, 1996, when liquifying was no longer required by EPA and on March 26, 1996, when drying the filtercake was no longer required by EPA. In 1995 and 1996, the contractor, 7-7, Inc. excavated 7,025.8 tons of Source Material, 5,334.0 cubic yards of hazardous debris and 843 tons of non-hazardous debris. A total of 4,614.7 of the 7,024.8 tons were handled through the liquefier (re-refining) process to yield 1,002,127 gallons of Fuel Product. The remaining source material consisted of 196.5 tons of filtercake that was screened and dried, and 2,214.6 tons of filtercake that was screened according to EPA's approvals. EPA's contractor, CH2M Hill, prepared the Closure Report for Phase I and Phase II. Because EPA's contractor GNB processed both source materials and contaminated soils and sediments, much coordination and negotiation occurred between EPA and ARAG to accomplish the cleanup.

A total of 4,072 tons of source materials requiring stabilization, and 532 tons of materials that did not require stabilization by a proprietary chemical lead stabilizing agent were disposed in off-site Subtitle D landfills. The ARAG disposed of source materials at the Lake Area Landfill for Phase 1, and EPA disposed of contaminated soils at Elk River Landfill for Phase 2; both had lined cells in which the materials were placed. Some debris, consisting of tree stumps, branches, peat, tires, soil and other miscellaneous material, was tested as hazardous and others were not hazardous, but all materials were sent to the appropriate type of facility (Subtitle C or D).

Soils and Sediments, Phase 2

EPA was responsible for the soils and sediments Phase 2 work. Soils and sediments above 500 mg/kg lead or visibly stained or discolored were excavated, treated on-site by a propriety chemical lead-stabilizing agent, and disposed. Once all excavation was completed, a visual verification was conducted. If there was a question about whether material was source material, a sample was collected for Toxicity Characteristic Leaching Procedure (TCLP) testing for lead or for carcinogenic PAH analysis. Five such samples were collected and were found not to be source materials (i.e. TCLP lead results <5 milligrams per liter (mg/L); total carcinogenic PAHs < 57 parts per million (ppm) and individual cPAHs < 5.7 ppm. Once all excavation was complete, photographs were taken and the excavated locations were visually inspected for any discoloration or staining indicated organic contamination. In addition to visual verification for organics, CH2M Hill collected and had analyzed verification samples that were collected on roughly 70-foot centers and analyzed for lead. No lead concentrations exceeded 500 milligrams per kilogram (mg/kg) and the average remaining lead content of the soils underlying the former sludge lagoon was 56 ppm.

In general, visibly contaminated soils were underlain by a blue-gray clay layer, which appeared to have acted as a barrier to further contaminant [downward] migration. A total of 456 tons of contaminated soils was excavated from beneath the former sludge lagoon during Phase 1 (Residuals RA). A total of 24,327 tons of contaminated soils were disposed during Phase 2 (Contaminated Soils and Sediments RA) that included the wastewater ditch sediments. A total of 48,050 tons of backfill was placed over the remaining soils and the wastewater ditch was completely filled in. The backfill for the cover was tested and met unrestricted use standards for

lead, (<100 mg/kg), carcinogenic PAHs (<1 mg/kg), and gasoline range organics (GRO)/ petroleum volatile organic compounds (PVOC) (<10 mg/kg). The backfill was covered by 4 to 6 inches of topsoil, which was seeded. The final grade was sloped slightly to the southwestern part of the Site. Other cleanup activities during source and soils and sediments excavation included:

- fenceline air quality monitoring;
- monitoring well abandonment in the excavation areas;
- disposal of 161 drums with investigation-derived waste remaining from several investigations conducted at the Site and 26 drums and pails from the Gopher Oil building;
- sampling and ensuring that decontamination water, ground water, and stormwater generated during the Remedial Action met discharge standards prior to discharge to the WLSSD sanitary sewer;
- disposal of a open-topped railroad car with heating coils. The railroad car contained oil saturated sand;
- demolition of most on-site buildings and a determination that there was no asbestos in the buildings; and
- underground storage tank disposal.

Ground Water Phase

The PRP group conducted the ground water construction. During the 1990 construction season, the Hermantown water main extension and connections were completed. The water main extension ran 3,300 feet from a tie-in at the corner of Highway 53 and Lavaque Bypass (formerly Ugstad Road). In all, 13 residences and businesses were connected to the water main. Following connection to city water, 10 private wells were sealed.

Construction of the ground water extraction and treatment system was completed on June 4, 1993. A ground water extraction system that consists of a French Drain with four manholes and sumps was fully installed with discharge to the WLSSD treatment facility. A year later, the EPA and MPCA determined that the ground water phase remedy was fully operational and functional, pursuant to 40 CFR 300.435(f)(2). The installed system, commonly known as a "French Drain", was designed to remove contaminated ground water prior to discharge to the WLSSD force main, and to prevent contamination movement beyond Site boundaries.

The purpose of the ground water extraction system was to remediate the ground water to MCLs and to prevent the off-site migration of contaminated ground water. In addition, the homes on Rose Road, south of Highway 53 adjoining the south side (downgradient side) of the Arrowhead Refinery Site were hooked up to city water. Three homes that were and are presently side gradient to the plume and are located on Lavaque Bypass Road east of the Arrowhead Refinery Site were not hooked up to city water and have not hooked up to date.

System Operations/O&M

Note that "O&M" is referred to throughout this document. At this Site, Long-Term Response Action is in progress for ten years until June 30, 2004. As such, "O&M" may be considered as "system operations" since this Site is not considered to be in the O&M phase as defined by the federal Superfund program while being remediated with federal funding.

System operations consist of a French Drain with a pump out system and discharge to the WLSSD sanitary sewer without treatment. The MPCA assumed responsibility for the ground water extraction system in July 1995. Since then, the MPCA's contractors have made weekly Site visits to perform regular maintenance and data collection, such as pump running time, flow totalizer readings, and discharge volume to the force main. An inspection of the French Drain and associated mechanical equipment occurs monthly when the discharge volume readings are taken. Samples of the discharge and water levels from all wells are collected quarterly. Nineteen wells are sampled semi-annually. The Site is inspected quarterly, including the physical condition of all equipment, the monitoring wells, and the land use. The O&M Manual is available, however it has been updated by the Annual Reports, more recent Quality Assurance Project Plans (QAPPs), and Site safety plans. A supplement to the O&M Manual will be created documenting changes to O&M.

System operations/O&M activities to date

See Response to Question A, Ground Water in the Technical Assessment portion of this document.

Problems in the implementation of system operations/O&M:

See response to Question A, Ground Water, in the Technical Assessment.

Costs

The 1986 ROD estimated annual O&M costs for the ground water extraction and treatment system to be $130,000 to $180,000 for 25 to 50 years. The 1994 AROD did not further address costs.

MPCA's actual annual O&M costs prior to and during the review period are detailed in Table 2, Annual System Operations/O&M costs. The state's fiscal year is July 1 through June 30, so this is the annual cost basis. Invoices for work prior to July 1, 2002 were still being processed at the end of the review period, August 30, 2002, so the annual cost for this fiscal year is incomplete.

In late 1998 and through the five-year review period, the MPCA saved about 50% of the cost of O&M by conducting much of the monitoring with MPCA staff instead of using a contractor. In the next five-year review period, we anticipate that contractors will be assigned the work again at the higher cost because of the reduction in MPCA Superfund Program staff. The O&M activities have not changed over the period.

Table 2: Annual System Operations/O&M Costs

	Dates		Total Cost
	From	**To**	**rounded to nearest $1,000**
	7/1/95	6/30/96	$89,000
	7/1/96	6/30/97	$100,000
Review Period	7/1/97	6/30/98	$92,000
	7/1/98	6/30/99	$48,000
	7/1/99	6/30/00	$43,000
	7/1/00	6/30/01	$52,000
	7/1/01	6/30/02	$41,000 (incomplete)

V. Progress Since the Last Review

The protectiveness statement from the last review is as follows:

"The ground water extraction system has achieved its design criteria and is effectively removing contaminants (VOCs, lead and PAHs) in the ground water. As noted above, cleanup goals have been achieved for all parameters with the exception of vinyl chloride, and this exceedance is restricted to one on-site monitoring well located between the source area and the ground water extraction system. No regulatory exceedances are present off-site as indicated by the monitoring well network downgradient from the extraction system. The recommendations given above will continue to provide adequate protection of human health and the environment."

Table 3: Actions Taken Since the Last Five-Year Review

Issues from Previous Review	Recommendations / Follow-up Actions	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
wells lost during excavations and replaced	Add new wells to the monitoring plan	MPCA	None	New wells added to the monitoring plan	September 1997
unknown whether bedrock is contaminated	Bedrock assessment	MPCA	None	Bedrock assessment conducted	1997-1998
vinyl chloride	Continue O&M and monitoring	MPCA	None	Continued O&M and monitoring	September 1997 to September 2002

The bedrock assessment was conducted. The Lenz private well was monitored once. Along with the other bedrock wells, some of which were monitored several times, the bedrock monitoring showed few detections. The bedrock assessment indicated no contamination above levels of concern and bedrock monitoring was discontinued from the monitoring plan.

The previous five-year review anticipated that the system could be shut off within five years. The current data indicates the rate of reduction of vinyl chloride is slowing, causing a longer period of continued O&M.

Implemented Actions for Ground Water

1. Continued monitoring of the Site extraction well system. Water levels are collected from all wells and four manholes quarterly. A list of 19 on and off-site wells are monitored semi-annually. The discharge is monitored quarterly for water quality and monthly for discharge volumes.
2. Annual monitoring reports were completed for 1996-1997, April 1998 to February 2000, February 2000 to March 2001, and Calendar Year 2001.
3. Reported monthly discharge volumes to WLSSD and discharge water quality reports quarterly to WLSSD.
4. Inspected the Site and well conditions quarterly.
5. Tranferred ownership of the force main to WLSSD on March 25, 1999. MPCA staff conditioned the transfer based on WLSSD consulting with MPCA on additional connections and reserving MPCA's right to the volumes needed for the RA.
6. Conducted natural attenuation monitoring twice in 2001.
7. Replaced well MW-3S after it was hit by a car and damaged beyond repair.
8. Completed memorandum regarding natural attenuation study and identification of possible modifications to the ground water remedy.
9. Participated and attended the sale of the Site property by St. Louis County. Assisted the County with preparing conditions for sale of the property and a draft of deed restrictions (see Attachment 7).
10. Had electrical work performed on the pump house due to a short in the system.

For more information, see VII. Technical Assessment, Question A, Recommendations and Actions Completed.

VI. Five-Year Review Process

Administrative Components

Potentially interested parties including MPCA and EPA management and staff counterparts were notified of the start of five-year review. The members of the review team included:

- MPCA SPM: Maureen Johnson
- MPCA Hydrogeologist: Barb Gnabasik
- Consultant: Delta: Keith Knoke, Karen Thole
- MPCA Public Information Officer: Anne Perry-Moore
- EPA RPM: Darryl Owens
- MDH Human Health Risk Assessor: Carl Herbrandson
- Ecological Risk Assessor: Steve Hennes.

A review schedule which addressed the following components of the five-year review was developed for February through August 2002:

Community Involvement,

Document review,

Data Review,

Interviews,

Site Inspection,

Five-Year Review Report Development and

Five-Year Review Report Reviews.

Community Involvement

The community was notified with a mailing to interested parties on an updated mailing list. Natural resource trustees were not included because the natural resource damages claims have been satisfied pursuant to the Consent Decree. The mailing contained the EPA fact sheet Focus on Five-Year Reviews and Involving the Community, and a notice with the following text:

> Announcement of a Five-Year Review
> for the
> Arrowhead Refinery Superfund Site
>
> The Minnesota Pollution Control Agency (MPCA) is conducting a Five-Year Review of the Arrowhead Refinery Superfund site (Site) cleanup, Hermantown, Minnesota. The EPA supports the Site cleanup and is participating in the review. This periodic review of the ongoing remedial action is required where hazardous substances, pollutants, or contaminants remain, which at this Site is lead, vinyl chloride and other contaminants from re-refined oil wastes.
>
> The purpose of the Five-Year Review is to determine continued adequacy and protectiveness of the remaining ongoing remedial action, pumpout of

contaminated ground water, and to evaluate whether the cleanup goals in the Site Record of Decision, as amended, remain protective of human health and the environment. The review will be completed by September 30, 2002.

The community can contribute by providing information that may have been observed at the Site or ways that the cleanup has helped the area. Local citizens are encouraged to bring information and any concerns related to the Site or requests for more information by August 19, 2002 to the attention of:

Anne Perry-Moore, Information Officer
Minnesota Pollution Control Agency
525 S. Lake Ave., Suite 400,
Duluth, MN 55802
(218) 723-2356
Toll-free 800-657-3864

or Maureen Johnson, Project Leader
Minnesota Pollution Control Agency
520 Lafayette Road N.,
St. Paul, Minnesota 55155
(651) 296-7353
Toll-free 800-657-3864

An EPA fact sheet is located at www.epa.gov/region5/superfund. Site documents are available for review at the Duluth Public Library, 520 2. Superior Street, Duluth, Minnesota. These will provide more detail on the selected remedy.

The remedy addressed protecting public health and the environment by preventing ingestion of contaminants found in the soil and ground water and by restoring the contaminated aquifer. The remaining contaminants are lead and diesel range organics in the soil, and lead, diesel range organics, and vinyl chloride in the ground water. The soils were cleaned up to an industrial cleanup level of 500 parts per million by 1997. An ongoing pumpout of contaminated water is preventing migration off-site.

A news release was faxed on July 31 to local television, radio and newspaper contacts:

NEWS RELEASE

Minnesota Pollution Control Agency

www.pca.state.mn.us

Toll-free and TDD 1 (800) 657-3864

Saint Paul • Brainerd • Detroit Lakes • Duluth • Mankato • Marshall • Rochester • Willmar

PUBLIC INPUT SOUGHT FOR ARROWHEAD REFINERY SUPERFUND SITE REVIEW

Duluth, Minnesota - The Minnesota Pollution Control Agency (MPCA) seeks public input as part of its review of the Arrowhead Refinery Superfund site cleanup. Community input is particularly helpful in two areas: observations of the site over time, and, ways the cleanup may have helped the area.

The Hermantown, Minnesota, site was formerly a waste oil recycling facility which produced highly acidic and metal-laden sludge. Improper disposal practices and discharges into the surrounding wetland contaminated the site. The site's contaminants are lead, vinyl chloride, and re-refined oil wastes. The contaminants were cleaned up to industrial levels, meaning once the contaminants were reduced to certain amounts the land could then be redeveloped for industrial use. (For example, lead levels were cleaned up to a maximum of 500 parts per million.) Ground water will continue to be pumped from the site until contaminant levels meeting drinking water standards are met.

Superfund sites, such as Arrowhead Refinery, that are cleaned up but have allowable levels of contamination to remain on site must be checked regularly to make sure the remedy was effective and continues to protect human health and the environment. To accomplish this, MPCA and EPA staff will inspect the site, review ground water monitoring data and site operation and maintenance reports, and collect public comments. This review will be completed by September 30, 2002.

Cleanup costs were paid by the companies directly responsible for the site's contamination, identified parties who sent their waste oil to the refinery, the EPA and the MPCA.

More detailed information about the site and the cleanup remedy are available for review in Duluth at the Public Library, 520 West Superior Street, and the MPCA, 525 Lake Avenue South, Suite 400. A related fact sheet is available online at www.epa.gov/region5/superfund
Comments must be received by August 31, 2002, and may be directed to:

Anne Perry Moore, Public Information Officer or Maureen Johnson, Project Leader

Minnesota Pollution Control Agency	Minnesota Pollution Control Agency
525 Lake Avenue South, Suite 400	520 Lafayette Road North
Duluth, Minnesota 55802	St. Paul, Minnesota 55155
218-723-2356	651-296-7353
Toll-free 800-657-3864	Toll-free 800-657-3864

As a result of the media contacts, the MPCA staff had calls from Gina Katzmark of KBJR-TV on July 31-August 1, Pat Kelly of KDLH-TV on August 1, John Myers of the Duluth News Tribune on August 5, Dan Schutte of WDIO-TV on August 6, and Wade Petrich of the Hermantown Star on August 15 and 22. KDAL radio requested short interviews, the last on July 31. They all asked similar questions about the cleanup process, status, cost, endpoint for water pumped off the Site and potential for redevelopment, restrictions to use of the Site, and the Five-Year Review seeking public comment or information. The MPCA Site file has copies of the two newspaper articles.

One non-media call for information came from the St. Louis County Solid Waste Department on August 5. On August 29 Hermantown City Planner asked by letter to be notified of any meetings and to be sent copies of any reports or other information published as part of the Five-Year Review.

The MPCA did not receive any calls or written comments from the public about this Site.

Document Review

Documents reviewed for this five-year review are referenced in Attachment 2. The applicable or relevant and appropriate cleanup standards and TBCs, as listed in the 1986 ROD and in the 1994 AROD, were reviewed.

Data Review

The previous five-year review did not address the source material and the soils and sediment phases, so data related to these phases were reviewed from initial response documents in 1979 to the Completion of Remedial Action Report/Completion of Work Report, 7-7, Inc. and SERVICE Environmental & Engineering, May 21, 1997. Ground water data was reviewed since the first five-year review in 1997. Refer to the Technical Assessment Portion of this five-year review for more detailed information and to Attachment 2 for the list of documents reviewed.

Site Inspection

A Site inspection for the five-year review was conducted on August 6, 2002. Refer to Attachment 3, Five-Year Review Site Inspection Checklist, a supplement to the checklist, a map with notes, and photographs.

Interviews

1. O&M Site Manager, Keith Knoke, and Staff, Karen Thole of Delta Environmental, Inc. were consulted for information as needed during the preparation of the five-year review.

A telephone interview was conducted by Maureen Johnson, Project Manager, with Bill Wilson, the new site property owner, on August 8, 2002. We discussed the inspection results regarding surface water flow and areas of soil settlement as it relates to his activities on the Site. The MPCA response will be a comparison between surveys of the property condition at RA completion in 1997 to current conditions, a hydrologic evaluation of the effects of the ponding water, and any necessary follow-up actions.

Successes/Problems

The Consent Decree, access agreements, and notice of deed restrictions had not been recorded at the St. Louis County Recorder's Office, as directed in the Consent Decree. This problem in the implementation of access and institutional controls was discovered in 1999 by newly assigned MPCA staff who were researching the status of the institutional controls The MPCA staff has since been researching files to identify appropriate deed restrictions and instruments. Draft restrictions were put in place when the County decided to auction the tax-forfeit parcels of the Site. Although access to the property had not been a problem, the fact that official agreements were not in place jeopardized future access. Finalization of restrictions, institutional control instruments, and access agreements are ongoing at the end of this five-year review period.

Successes/problems with the construction of the sources/soils remedies are described in the Phase I Residuals, Phase II Contaminated Soils and Sediments Remedial Action Closure Report. In all, the remedial actions were fully performed and the performance standards were met. The RA was completed in accordance with the 1994 AROD. Although no operation or maintenance was indicated for these RAs, settlement, erosion and ponding need to be addressed.

Successes/problems with system operations/O&M are described in VII. Technical Assessment. The ground water is being cleaned up faster than the 1986 and 1994 models indicated.

VII. Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

Source Materials, Soil and Sediment Phases

Generally, the remedy is functioning as intended by the decision documents. The remedial actions for the source materials, soil, and sediments consisted of excavation, treatment on-site and off-site disposal. Excavations of visibly contaminated soils with organics and of lead contaminated soils were conducted in 1995 and 1996. The excavation actions, replacement fill, grading, and topsoil cover of the Site continue to meet cleanup levels, as described in further detail below. At present, there may be potential effects due to lead exceeding the new Tier 2 SQT of 130 mg/kg in sediments of the EPA drainage ditch south of the former Gopher Oil Building and downstream of it to the Highway 53 culvert (RI sampling 1985). Sediment sampling has not been conducted since the RI sampling in 1985. With regard to functioning as designed, there are some settled areas that may need fill to final grade. Also, it appears that drainage modifications were made since close out of these RA phases in 1996, and there are drainage issues that need resolution at the Site. Deed restrictions need to be finalized and filed with the property deed.

MPCA staff inspected the surface water drainages at the Site as part of the five-year review inspection. Based on our inspection, the present drainage pattern is shown on Figure 1 in the Five-Year Review Inspection Record Attachment 3. The EPA ditch still partially flows to the east and around the south side of the Site. However, at some point in time, the EPA drainage ditch was extended to the west by an unknown party on the north side of the Site to a county ditch that runs from the north along the entire west side of the Site. This county ditch drains to the culvert at Highway 53 in the southwest corner of the Site. This culvert appears blocked and surface water is backing upflow of it and forming a pond. The Site surface still slopes to the west-southwest as constructed. Two tributary swales, located on the southwest and west sides of the Site also are present. The swale on the west side of the Site has some ponding north of Manhole 1 and there is overland flow from this swale for the last 50 feet or so to the county ditch. The swale on the southwest side of the Site, directly west of the Hom Furniture Warehouse (the former Gopher Oil building), drains into the Highway 53 ditch. A review of the final elevations, as shown in Figure 3 of Appendix K in the CH2M Hill *Soils and Sediments Closure Report,* does not show construction of any drainage ways that discharge into the EPA ditch around the Site perimeter and is not large enough to show final elevations beyond the immediate construction area. There is further discussion of the existing ditches below under Question B as there are some new sediment SQTs.

The draft deed restrictions require that:

> (a) The Property shall be used solely for restricted industrial or restricted commercial purposes and shall never be used for purposes which may provide exposure routes for sensitive subpopulations including children, the elderly, the infirm, or others; such as but not limited to family housing, condominiums or apartments, schools, hospitals, nursing homes, day-care centers, playgrounds, recreation areas, or other similar purposes;

(b) No excavation shall be performed on the Property and no underground structures or basements shall be constructed on the Property (other than footings for above-ground structures and septic tanks) without MPCA approval.
(c) The french drain, sumps, pump house and instrumentation, piping from sumps to the pumphouse and from the pumphouse to the sanitary sewer line that parallels Highway 53, associated electrical connections, monitoring wells, and protective posts, and any future improvements to the remediation system shall not be disturbed in any manner;
(d) No connection shall be made to any utilities, including the sanitary sewer, electrical or telephone utilities, which are part of the Site fixtures. The Owner may need to obtain independent connections to utilities and not affect those utilities related to the remedial actions for the Site; the force main, a portion of the drainage system installed for the cleanup, is now owned and controlled by WLSSD. The sewer line was designed for the Arrowhead cleanup, so developers should not assume that connection to the line will be approved for other purposes. Consultation with WLSSD is essential prior to design and cost estimates for sewer connections.
(e) No change shall be made to the water table, surface water drainage, ditches, or infiltration to the water table in such a manner that may affect the ability of the Site to be remediated or to remain protective;
(f) The Minnesota Department of Natural Resources and the U.S. Fish and Wildlife Service require, due to the remaining lead on Site, that restoration of wetland, ponding, and water features that draw wildlife are not allowed.
(g) No wells and no drinking water wells shall be installed on the Site.
(h) Compliance with the Consent Decree. The Consent Decree must be filed at the St. Louis County Recorder's Office to fulfill Consent Decree conditions. The Consent Decree included the provision of access for MPCA to operate, maintain, improve, and remove remedial actions, and
(i) Cooperation with the MPCA to complete the cleanup of the Site and conduct periodic future reviews is required; and
(j) No activity shall be permitted that adversely affects the protectiveness of the response actions at the Site.

There are no areas of noncompliance for the soils except with regard to the need to file the deed restrictions. The soils and sediments phases are closed. However, since they were closed, a few drainage and sediment issues have arisen. These issues also are discussed below in the responses to Questions B and C.

Ground Water Phase

The ground water remedy is functioning as intended by the decision documents. It operates and functions as designed, and is performing as expected. In this document, the ground water extraction system will be evaluated in three ways: 1) mechanical performance and reliability of the ground water extraction system; 2) hydraulic containment; and 3) ground water cleanup. A discussion regarding compliance with WLSSD discharge requirements is included.

Mechanical performance

There have been few mechanical breakdowns that have required repairs. The only repair that MPCA staff is aware of is a recent electrical problem with a ground wire that required electrical rewiring. The only other times that shut down has occurred is when WLSSD shut down the ground water extraction system due to peak overload at the WLSSD treatment plant by all users. The ground water extraction system was restarted in three days in each of these cases. With the expansion that occurred within the last year at WLSSD, shutdowns due to peak overload at WLSSD treatment plant should no longer be an issue.

Pumping in the ground water extraction system maintains a consistent water level and varies with precipitation. Monthly monitoring of discharge volumes is required by WLSSD. Ground water discharge volumes for the ground water extraction system are in the annual monitoring reports. With a few exceptions, the discharge volume has been fairly consistent for the past five years, ranging between 700,000 and 1.4 million gallons per month. The exceptions are related to the WLSSD shutdown and the electrical problem discussed earlier. See Attachment 4 for a chart of the discharge volumes through time.

A summary of quarterly monitoring results of the contaminant concentrations from the ground water discharge is provided in Table 2 of the August 26, 2002 memorandum (see Attachment 6) regarding natural attenuation status and achieving Site cleanup standards. The WLSSD allowed limits are: cis-1,2-dichloroethene 1,000 ug/L; trans-1,2-dichloroethene 1,000 ug/L; trichloroethene 1,000 ug/L; vinyl chloride 1,000 ug/L; total VOCs, 3,000 ug/L; Gasoline Range Organics (GRO) 100,000 ug/L; diesel range organics Diesel Range Organics (DRO) 100,000 ug/L; and total lead 3,000 ug/L. No single chlorinated VOC or total VOCs have exceeded these allowed limits in the past five years. GRO and DRO have not been detected in the past year. Total lead is only sporadically detected and at very low concentrations of up to 39 ug/L.

Hydraulic Containment

The first five-year review indicated that ground water flow direction at the Site, prior to construction and operation of the French Drain, was southwesterly in the northern portion of the Site and more westerly in the southern portion of the Site.

From June 1993 to spring of 1997, a ground water elevation of 1405 feet elevation was maintained in the French Drain. For further information, refer to the First five-year review.

During the last five-year review process, the ground water capture zone was found to be more than adequate across the Site. As a result, a decision was made to raise the ground water elevation in the trenches from 1405 feet to 1407 feet elevation. The higher discharge rate that resulted from the 1405 feet elevation was no longer necessary as the source material remediation activity was completed and dewatering for excavation operations was no longer necessary. The adjustment to an elevation of 1407 feet was completed in May 1997. A water table contour map for the Site in May 1997 is provided on page 9 of the first Five-Year Review. This figure shows that an adequate zone of capture across the Site was maintained. Ground water flow directions remained consistent with previously observed flow directions.

Since May 1997, the ground water containment system continues to be operated effectively at the 1407 foot ground water elevation in the trenches. See the July 2001 ground water contour map in Attachment 6 and the ground water elevations in Attachment 5. There are ground water contour maps for each event in which water levels were measured in the annual reports.

Ground Water Analytical Evaluation

Historically, many of the on-site downgradient ground water monitoring wells had significant exceedances of MCLs on-site, while the exceedances in the downgradient off-site monitoring wells have been limited to detections below MCLs on an infrequent basis. The on-site downgradient monitoring wells that have historically shown exceedances above MCLs include well locations MPCA-4, MPCA-5, and MW-14. Starting in December 1994, the MDH has promulgated Health Risk Levels (HRLs) for many contaminants. Subsequently, the MDH has provided Health Based Values (HBVs) for contaminants, which may be promulgated in the future. Both HRLs and HBVs are based on carcinogenic and/or hazard index properties, and the MPCA uses these numbers to make decisions. A summary of the current MCL standards and newer standards, including the legally promulgated HRLs and the advisory HBVs, are provided in Table 4A. For ground water, only the MCL for vinyl chloride will significantly affect ground water cleanup at the Site. A discussion of the standard for vinyl chloride is found in the August 26, 2002 memorandum (see Attachment 6).

Please refer to the August 26, 2002 memorandum regarding the status of natural attenuation and achieving Site cleanup standards at the Site, Attachment 6. The methods and findings of the natural attenuation study are discussed, and recommendations are made to monitor natural attenuation and continue the O&M, and to reduce the sampling program. The discharge is strongly reducing and it is apparent that anaerobic degradation of vinyl chloride continues to occur at the Site. A limiting factor controlling the rate of further degradation of vinyl chloride at the Site may be a limited carbon source. The ethene and ethane data, however, indicate that natural attenuation is occurring. According to the model, cleanup may occur within the next 5 ½ years.

The August 26, 2002 memorandum also discusses several possibilities of enhancing natural attenuation but recommends continuing the current non-enhanced natural attenuation remedial action. The recommendation for the existing O&M is in the same price range and effectiveness as enhanced anaerobic degradation. Enhanced anaerobic degradation would not guarantee faster cleanup, would require additional funding up front, and would consume more staff time which is less available due to MPCA Superfund staff reduction and attention to other priorities. Aerobic degradation is rejected because it would involve changing the aquifer to aerobic, dealing with metals fouling, and would cost more in time and money.

The May 1997 Five Year Review stated that contaminants are limited to positive detections of 1,1,2-trichloroethene and related degradation products, lead, and carcinogenic PAHs (cPAHs). The authors concluded that data show little overall change with respect to distribution of the contaminants in ground water over time except for well MW-16S. VOCs, DRO, GRO, and lead have not been detected off-site in the past five years and on-site detections of these parameters are very limited. Furthermore at the time of the first review, it was indicated that VOCs are naturally attenuating anaerobically at the Site.

A number of PAHs were detected in well MW-16S for the first time as part of the March 1997 sampling event. The first five-year review stated that continued monitoring of this well would be performed as part of the routine sampling plan. This well was resampled for PAHs in October 1997. Only well MW-16S, which is an off-site shallow well, and the extraction system discharge had any detections of PAHs as part of either sampling event. Based on the information available to date, the detection of PAHs in well MW-16S is not an issue of concern for the following reasons:

- There has been hydraulic containment of the plume on-site at least since 1995, when MPCA took over the O&M for the ground water Phase;
- There are monitoring well nests MW-9 and 10 directly downgradient of the French Drain and upgradient of well MW-16S and the wells in these two nests have not had any detections of PAHs;
- A comparison of the HRLs to the PAH concentrations detected in well MW-16S and the discharge show that there are no exceedances of HRLs at either location for either the March or the October 1997 sampling dates. Noncarcinogenic PAHs that had HRLs were compared to individual HRLs and cPAHs were converted to benzo(a)pyrene (BaP) equivalents. The BaP equivalents for well MW-16s and the discharge at their highest concentrations were 0.014 and 0.002 ug/L, respectively. Note that the concentration for BaP equivalents is higher in well MW-16S than in the discharge.
- PAHs are relatively insoluble and no other contaminant of concern was detected in well MW-16S;
- DRO concentrations are nondetect in the discharge and all monitoring wells except one on-site well (MPCA-4A) that is on-site, upgradient of the French Drain and it only slightly exceeds the HBV of DRO + GRO = 200 ug/L. This is likely due to a remnant of petroleum-contaminated soils that were found and excavated during the installation of the French Drain.

Therefore, detection of PAHs in ground water is no longer an issue at the Site.

Refer to the August 26, 2002 memorandum regarding the areas of noncompliance for ground water.

Opportunities for Optimization

The August 26, 2002 memorandum in Attachment 6 discusses the possibilities of supplementing the current ground water system to speed up cleanup. It concluded that the current natural attenuation remediation will achieve nearly the same results for approximately the same cost, although the extraction system will be operating for additional years.

Early Indicators of Potential Issues

No equipment breakdowns or changes indicate a potential issue.

Implementation of Institutional Controls and Other Measures

Because the source materials and contaminated soils and sediments were excavated and the Source Materials and the Soils and Sediments Phases were closed, it was decided that access to the Site no longer needed to be restricted. Therefore, the fence around the Site was removed as discussed on Page 11 of the CH2M Hill Closure Report.

The zoning for industrial/ restricted commercial is in place and prevents exposure. As discussed above, the draft deed restrictions need to be finalized. A copy of the draft Restrictive Covenant is attached as Appendix 7. This will help to prevent future exposure.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection still valid?

Changes in Standards and TBCs

Some standards identified in the ROD have been revised; there are newly promulgated standards; and To Be Considered (TBC) criteria used in selecting cleanup levels at the Site have changed; some of these may call into question the protectiveness of the remedy.

For Source Materials: The source materials were completely excavated and there are no issues. This phase is closed.

For Soils: There are revisions to the TBCs. See Tables 4A, B, and C below for a list. In 1998 the MPCA developed Soil Reference Values (SRVs). An SRV is a soil concentration which corresponds to a specified target risk level based on a specific exposure scenario. An SRV is used as a decision criteria in assessing potential human health concern at contaminated sites. The 1994 AROD contains a list of maximum concentrations found in soils prior to excavation and disposal in 1995 and 1996. Only carbon tetrachloride and 1,2-dichloroethane maximum concentrations exceed the new TBCs. These new TBCs for carbon tetrachloride are 0.7 mg/kg for the industrial SRV and the 3.5 mg/kg short-term worker (STW) SRV. For 1,2-dichloroethane the new TBC is 6 mg/kg for industrial SRV and STW SRV. Industrial and STWs are applied to the top four feet of soils. The old TBCs for carbon tetrachloride and 1,2-dichloroethane were 440 and 629 mg/kg, respectively. The old cleanup numbers now represent a Hazard Quotient of 97.778 and an Excess Lifetime Cancer Risk of 9.78E-4 for carbon tetrachloride and a Hazard Quotient of 10.483 and an Excess Lifetime Cancer Risk of 1.05E-3 for 1,2-dichloroethane. The Hazard Quotient for carbon tetrachloride is greater than one. For 1,2-dichloroethane, the Hazard Quotient is greater than one and the Excess Lifetime Cancer Risk is outside the 10^{-4} to 10^{-6} risk range. Therefore, the new assessment numbers apply. MPCA staff checked locations where carbon tetrachloride and 1,2-dichloroethane concentrations that exceed the SRVs at the Site were detected. Carbon tetrachloride was detected once at soil sampling location S08 from 4.5 to 6.4 feet depth and the concentration detected was 6.4 mg/kg. The contaminant, 1,2-dichloroethane also was only detected once in sample S087-5e* at a depth of 5 to 6 feet and the concentration was 310 mg/kg. Both sample locations are in the former Process Area (see Figure D-5 of FDI) and the two VOCs were detected above cleanup levels only in areas of excavation and disposal (see Figure 2 in Appendix K of CH2M Hill's Soils and Sediments Close-Out Report (November 1996).

Note that the soil sample detection depths for both samples are below four feet, so technically the industrial and STW SRVs would not apply and only a leaching number would apply. Although leaching numbers typically are applied from the ground surface to the water table, at this Site, leaching numbers are not presented because:

- there are very few contaminants being detected in the ground water at levels of concern and the contaminants only include vinyl chloride, DRO/GRO, and lead;
- carbon tetrachloride and 1,2-dichloroethane are fairly mobile in nature, but there are no detections of carbon tetrachloride and no detections near, at or above ground water standards for 1,2-dichloroethane; and

- the soils had ample opportunity to leach.

A map of the depths of excavation is not included in the November 1996 Close-Out Report but it is assumed that the visual standard for soil cleanup was adequate, given the list of reasons stated above. Therefore, the maximum contaminant concentrations in soils are not considered an issue and were likely excavated.

For Sediments: There are several new TBCs that apply to sediments as listed in Table 4A, below. These TBCs are sediment specific standards and are applied to the present day ditches at and surrounding the Arrowhead Refinery Site, including:

- the EPA ditch;
- the part of the ditch on the north side of the Site that connects the EPA ditch to the County ditch on the west side of the Site;
- the County ditch; and
- the two on-site tributaries on the west and southwest sides of the Site that discharge to the County ditch and the EPA ditch, respectively.

The source of these TBCs is work directed by MPCA staff, in published work (see references, Crane and Others, December 2000) for the St. Louis River watershed sediments, which are part of the St. Louis River/Interlake/Domtar/USSteel NPL Superfund Site. The Arrowhead Refinery Site is located in the St. Louis River watershed. Refer to the document, "Development of a Framework for Evaluating Numerical Sediment Quality Targets and Sediment Contamination in the St. Louis River Area of Concern" and specifically to Tables 14 and 15 in this cited document. The website for the document is:

http://hubble.pca.state.mn.us/water/sediments/studies-stlouis.html.

Three new Tier 2 SQTs, 130 mg/kg for lead, 49 mg/kg for nickel, and 460 mg/kg for zinc are lower than the maximum concentrations listed as being detected prior to excavation, treatment, and disposal off-site. The maximum concentrations are listed in the 1994 AROD and are summarized below. All maximum concentrations are based on results from a November 6, 1985 sampling event and are based on locations of exceedances in the EPA ditch. A map of the sampling locations is attached.

A summary of the lead, nickel, and zinc data, including background data, are summarized below.

Metals Summary Chart

Sampling Location	Sampling Event	Lead (mg/kg)	Nickel (mg/kg)	Zinc (mg/kg)
New Sediment SQT		*130*	*49*	*460*
Background #s		38	42.1	107.9
SD-1		- / 14	28 / 25	43 / 76
SD-2	Phase 1 / 2 RI	11 / 36	20 / 39	**14,007** / 109
SD-3		- / 5.5	- / 32	84 / 62
SD-4	Phase 1 / 2 RI	- / **271**	34 / **71**	49 / 374
SD-5	Phase 1 / 2 RI	78 / **154**	- / 39	238 / 215
SD-6	Phase 1 / 2 RI	**152** / 46	23 / 22	100 / 98
SD87-4	FDI (RD)	Not Analyzed	22.2 / 22.6	267 / 237
SD87-6	FDI (RD)	Not Analyzed	36.4 / 17.8	135 / 70.5
SD87-11	FDI (RD)	Not Analyzed	17.8 / Not Anal.	199 / 45.1
SD87-12	FDI (RD)	Not Analyzed	25 / 21.8	**1350** / 188

CH2M Hill concluded, on behalf of EPA, that the exceedances were single spot exceedances and did not show a pattern of concentrations in sediments decreasing with distance from the Site based on the RD April 30, 1990 FDI by CH2M Hill. The FDI stated, "although a large number of the maximum concentrations were found south of the Gopher Oil Building at SD4, there does not appear to be a decreasing trend away from that location indicating that the contamination at SD4 is localized."

It appears as if the elevated nickel and zinc concentrations are sporadic and are not consistent. At SD-4 and downstream of it (SD-5 and SD-6), there was a decreasing trend for lead. In CH2M Hill's FDI, the lead cleanup number of 500 mg/kg was the same as the soil cleanup number. Therefore, given the 500 mg/kg lead cleanup level, the lead concentrations in the EPA ditch in front and downstream of the Gopher Oil Building were not of concern. But when compared to a Tier 2 SQT of 130 mg/kg, the three lead concentrations in the EPA ditch south of the Gopher Oil Building (now the Hom Furniture Warehouse) and downstream of it would be of concern for potential impacts to aquatic organisms. Also, there was a pattern of decreasing concentrations with distance from the Site. Therefore, MPCA staff recommends that the issue of potential impact to aquatic organisms by lead concentrations in the EPA ditch south of the Gopher Oil Building to the culvert north of Highway 53 exceeding the Tier 2 SQT of 130 mg/kg be evaluated. This issue should be resolved prior to opening the plugged culvert north of Highway 53 to prevent transport of sediments with new flow before we know the contaminant levels in the sediments.

For Ground Water: See Tables 4A, 4B, and 4C below and the August 26, 2002 memorandum. The new state-promulgated HRL standards for ground water use a 10^{-5} risk level as their basis. The MDH developed an advisory HBV of 200 ug/L for DRO and GRO (Total Petroleum) in ground water.

Based on the information presented in Table 4C below, arsenic, hexavalent chromium, vanadium, and zinc were detected once above current MCL and TBC numbers for these four metals in former source well B4a (see Table D–18 of the 1990 FDI Report). This well was screened in the peat, where it was mixed with the source material. The peat and the source material were excavated in 1995 and 1996. As no confirmatory samples were ever collected for these four metals in this former well and the well is now sealed, MPCA staff proposes to sample the new well MPCA-4A, screened in the outwash that underlies the peat, and the extraction system discharge for these four metals in October 2002 to obtain confirmatory results. Zinc was detected once in well MW-14A at concentration of 4,640 ug/L which exceeds the HRL. (see Table D–18 of the 1990 FDI Report). A second zinc sampling result for this well was 35.6 ug/L. MPCA also proposes to collect a zinc sample from well MW-14A in October 2002, as a confirmatory result. Finally, the ground water TBC cleanup number for 4-methylphenol was changed to 3 ug/L. With this change, there are five wells where the historical concentrations detected would exceed the new TBC number.

Locations Where New HRLs Are Exceeded Chart

Sampling Location	Is Well Sealed?	4-Methylphenol Concentration Detected
MW-7A –	Yes	29 ug/L
MW-3S	No	16 ug/L
B4a	Yes	400 ug/L
B4a	Yes	120 ug/L
B5	Yes	230 ug/L
MW-14S	No	5 ug/L

The source of this information is Table D-15 of the 1990 FDI. MPCA proposes to sample wells MW-3S, MW-14S, MPCA-4A, MPCA-5A and the extraction system discharge for SVOCs in October 2002 to determine whether 4-methylphenol is still present. MPCA staff does not expect to detect the four metals, 4-methylphenol or 1,4-dioxane above MCLs, HRLs, HBVs or other TBC number as documented in Table 4A.

Changes in Exposure Pathways

There have been no changes in land use, which remains zoned as industrial / restricted commercial and used for one warehouse and otherwise as open land.

There are no changes in human health or ecological routes of exposure and no receptors have been newly identified.

Vinyl chloride was anticipated as a byproduct of degradation. There are no newly identified contaminants or contaminant sources and no unanticipated toxic byproducts. Because 1,4 dioxane has been found to be often in association with TCE at other sites, the presence of 1,4-dioxane in ground water will be sampled and analyzed for in October 2002. Exceedance of any TBC number is not expected.

New understandings of conditions and some minor changes in Site physical conditions may in some issues which may affect the protectiveness of the remedy for the environment. MPCA staff recommends that the lead in the sediment for the ditch in front of the Gopher Oil Building (now Hom Furniture Warehouse) and downstream be evaluated as to whether there are impacts to aquatic organisms. The potential for impacts is based on a new lead sediment Tier 2 SQT of 130 mg/kg. Drainage patterns and sediment conditions at the Site are changing because of settlement and an apparent plugged culvert.

Changes in Toxicity and Other Contaminant Characteristics

While changes have occurred for toxicity of several contaminants in soil, none of the changes affect the protectiveness of the remedy. Based on the evaluation of changes below in Tables 4A, 4B, and 4C, and the comparison of new soil TBC numbers, changed soil cleanup numbers, and the maximum on-site concentrations listed in the 1994 AROD, the remedy remains protective. No maximum concentrations cited in the 1994 AROD for the Site currently exceed risk-based values, except for carbon tetrachloride and 1,2-dichloroethane. MPCA staff reviewed the data files and found that carbon tetrachloride and 1,2-dichloroethane were only detected in the process area at depth, and these soils were likely excavated in 1995 and 1996. Carbon tetrachloride and 1,2-dichloroethane are not currently contaminants of concern for ground water. Therefore, these two VOCs are not a concern in soil and the remedy of excavation remains protective.

For sediments, new information from the St. Louis River sediment studies in how sediment risk assessment is performed and the changes in methods of evaluation are the primary sources of the changes listed in the tables below. As stated above, MPCA staff recommends evaluation of potential impacts to aquatic organisms caused by lead concentrations in sediments of the EPA ditch south of the Gopher Oil Building and downstream of it to the culvert north of Highway 53 exceeding the Tier 2 SQT of 130 mg/kg.

For ground water, the sum of trihalomethanes (bromoform, chlorodibromomethane, chloroform, and bromodichloromethane), 2-butanone, and arsenic have changed in toxicity. New information regarding toxicity of the following contaminants of concern has allowed development of additional HRLs and HBVs. The source of this information is typically the EPA's Integrated Risk Information System (IRIS). The contaminants of concern with standards or criteria developed since the 1994 AROD was written include: 1,4-dioxane; 1,1-dichloroethane; chloroethane; cis-1,2-dichloroethene; DRO + GRO; 4-methylphenol; acenaphthene; anthracene; fluoranthene; fluorene; pyrene; carcinogenic PAHs; trivalent and hexavalent chromium; lithium; strontium; and zinc. Only DRO/GRO in this list, has been detected sporadically in water samples collected from on-site well MPCA-4A at concentrations above the HBV of 200 ug/L. Results from confirmatory sampling are not expected to exceed TBCs.

There have been no changes in contaminant characteristics that could affect the protectiveness of the remedy.

Changes in Risk Assessment Methods

For ground water and soil, there are no changes in standardized risk assessment methodologies that could affect the protectiveness of the remedies except for carcinogenic PAHs. Carcinogenic PAHs now use an additivity approach based on the product of the potency factor and the specific cPAH concentration detected. Based on the revised TBC numbers, cPAHs are not a concern for ground water and soil as the Site.

Methods for developing sediment screening numbers have changed to a great degree. Changes to sediment screening numbers are contained within the document, "Development of a Framework for Evaluating Numerical Sediment Quality Targets and Sediment Contamination in the St. Louis River Area of Concern." The SQTs are provided in Tables 14 and 15 of the cited document. The website for this document is:

http://hubble.pca.state.mn.us/water/sediments/studies-stlouis.html.

Pursuant to the federal Safe Drinking Water Act (SDWA), MCLs are based on health (using the federal risk database known as IRIS), cost, technological feasibility, detection level, ability for consistent lab results, and other factors. The state's MDH uses IRIS numbers in addition to a number of other sources and professional judgment to develop the HRLs (promulgated in state rules) and HBVs (new advisory numbers likely to be promulgated). The HRLs and HBVs are strictly health-based and use a 10^{-5} risk level as the basis for acceptable risk. The MPCA uses the HRLs and HBVs to evaluate risk, then incorporates feasibility, cost, etc. into its cleanup decisions.

Expected Progress Towards Meeting RAOs

For ground water, progress toward meeting RAOs is much better than expected. The original projected time for ground water cleanup was up to 25 to 50 years. At the present rate of biodegradation, the ground water is projected to meet MCLs within the next 4 to 8 years (6.2 years as calculated in the Memorandum). However, this rate may slow with decreasing carbon/food sources. Refer to the August 26, 2002 Memorandum, in Attachment 6, with regard to achieving ground water cleanup standards.

Table 4a. Changes in Chemical Specific Standards, Criteria, and Screening Levels

Contaminant	Media	Cleanup Level or Tier 2 SQT (Sediment Screening Number)	Standard, TBC, or Sediment Screening Tier 2 SQT		Citation/Year
Soils and Sediments					
Lead	Soils	None Available	Previous	500 mg/kg	According to P.21 of AROD, based on Office of Solid Waste and Emergency Response (OSWER) Directive #9355.4-02, "Interim Guidance on Establishing Lead Cleanup Levels in Soil", September 1, 1989.
Lead	Soils	700 mg/kg industrial, 400 residential	New	700 mg/kg, 700 mg/kg (reclass. As a carcinogen)	Industrial SRV, STW SRV; (MPCA, 1/99)
Benzene	Soils	1,974 mg/kg	Previous	1,974 mg/kg	
Benzene	Soils		New	4 mg/kg, 10 mg/kg	Indust. SRV, STW SRV; (MPCA, 1/99)
2-Butanone	Soils	1.23E6 mg/kg	Previous	1.23E6 mg/kg	
2-Butanone	Soils		New	4300 mg/kg, 1240 mg/kg	Indust. SRV, STW SRV; (MPCA, 1/99)
Carbon Tetrachloride	Soils	440 mg/kg	Previous	440 mg/kg	
Carbon Tetrachloride	Soils		New	0.9 mg/kg, 3.5 mg/kg	Indust. SRV, STW SRV; (MPCA, 1/99)

Chloroform	Soils	2.04E4 mg/kg	Previous	2.04E4 mg/kg	
Chloroform	Soils		New	4 mg/kg, 4 mg/kg	Indust. SRV, STW SRV; (MPCA, 1/99)
1,2-Dichloroethane	Soils	629 mg/kg	Previous	629 mg/kg	
1,2-Dichloroethane	Soils		New	6 mg/kg, 6 mg/kg	Indust. SRV, STW SRV; (MPCA, 1/99)
Methylene Chloride	Soils	1.23E5 mg/kg	Previous	1.23E5 mg/kg	
Methylene Chloride	Soils		New	158 mg/kg, 158 mg/kg	Indust. SRV, STW SRV, (MPCA, 1/99)
1,1,2-Trichloroethane	Soils	8,176 mg/kg	Previous	8.176 mg/kg	
1,1,2-Trichloroethane	Soils		New	14 mg/kg, 14 mg/kg	Indust. SRV, STW SRV (MPCA, 1/99)
Trichloroethene	Soils	5,203 mg/kg	Previous	5,203 mg/kg	
Trichloroethene	Soils		New	46 mg/kg, 46 mg/kg	Indust. SRV, STW SRV, (MPCA, 1/99)
Benzo(a)anthracene	Soils	78 mg/kg	Previous	78 mg/kg	
Benzo(a)anthracene	Soils		New	See cPAHs	
Benzo(a)pyrene	Soils	8 mg/kg	Previous	8 mg/kg	
Benzo(a)pyrene	Soils		New	See cPAHs	
Benzo(b)fluoranthene	Soils	78 mg/kg	Previous	78 mg/kg	
Benzo(b)fluoranthene	Soils		New	See cPAHs	
Benzo(k)fluoranthene	Soils	784 mg/kg	Previous	784 mg/kg	

Benzo(k)fluoranthene	Soils		New	See cPAHs	
Bis(2-ethylhexyl)phthalate	Soils	2.1 mg/kg	Previous	2.1 mg/kg	
Bis(2-ethylhexyl)phthalate	Soils		New	2100 mg/kg, 5000 mg/kg	Indust. SRV, STW SRV; (MPCA, 1/99)
Butylbenzylphthalate	Soils	4.09E5 mg/kg	Previous	4.09E5 mg/kg	
Butylbenzylphthalate	Soils		New	3700 mg/kg, 31,450 mg/kg	Indust. SRV, STW SRV, (MPCA, 1/99)
Carcinogenic PAHs	Soils	No Cleanup Number	Previous	No Cleanup Number	
Carcinogenic PAHs	Soils		New	4 mg/kg BaP Equiv., 10 mg/kg BaP Equiv.	Indust. SRV, STW SRV; (MPCA, 1/99)
Chrysene	Soils	784 mg/kg	Previous	784 mg/kg	
Chrysene	Soils		New	See cPAHs	
Dibenz(a,h)anthracene	Soils	8 mg/kg	Previous	8 mg/kg	
Dibenz(a,h)anthracene	Soils		New	See cPAHs	
Dibenzofuran	Soils	6,176 mg/kg	Previous	6,176 mg/kg	
Dibenzofuran	Soils		New	810 mg/kg, No STW SRV	Indust. SRV, STW SRV; (MPCA, 1/99)
Fluorene	Soils	8.2E4 mg/kg	Previous	8.2E4 mg/kg	

Fluorene	Soils		New	4,120 mg/kg 17,240 mg/kg	Indust. SRV, STW SRV; (MPCA, 1/99)
Naphthalene	Soils	None	Previous	None	
Naphthalene	Soils		New	28 mg/kg, 78 mg/kg	Indust. SRV, STW SRV, (MPCA, 1/99)
Phenol	Soils	1.22E6 mg/kg	Previous	1.22E6 mg/kg	
Phenol	Soils		New	26,800 mg/kg, 15,070 mg/kg	Indust. SRV, STW SRV, (MPCA, 1/99)
Pyrene	Soils	6.13E4 mg/kg	Previous	6.12E4 mg/kg	
Pyrene	Soils		New	5,800 mg/kg, 43,000 mg/kg	Indust. SRV, STW SRV, (MPCA, 1/99)
Aluminum	Soils	None	Previous	None	
Aluminum	Soils		New	100,000 mg/kg, No STW SRV	Indust. SRV, STW SRV, (MPCA, 1/99)
Antimony	Soils	None	Previous	None	
Antimony	Soils		New	100 mg/kg, 100 mg/kg	Indust. SRV, STW SRV, (MPCA, 1/99)
Beryllium	Soils	None	Previous	None	
Beryllium	Soils		New	290 mg/kg, 800 mg/kg	Indust. SRV, STW SRV, (MPCA, 12/99)
Cobalt	Soils	None	Previous	None	
Cobalt	Soils		New	3,000 mg/kg, No STW SRV	Indust. SRV, STW SRV, (MPCA, 1/99)
Copper	Soils	None	Previous	None	

Copper	Soils		New	9,000 mg/kg, 9,000 mg/kg	Indust. SRV, STW SRV, (MPCA, 1/99)
Mercury	Soils	None	Previous	None	
Mercury	Soils		New	2 mg/kg, 0.7 mg/kg	Indust. SRV, STW SRV, (MPCA, 1/99)
Nickel	Soils	None	Previous	None	
Nickel	Soils		New	3,000 mg/kg, 3,000 mg/kg	Indust. SRV, STW SRV, (MPCA, 1/99)
Vanadium	Soils	None	Previous	None	
Vanadium	Soils		New	1,340 mg/kg, 1,340 mg/kg	Indust. SRV, STW SRV, (MPCA, 1/99)
Zinc	Soils	None	Previous	None	
Zinc	Soils		New	70,000 mg/kg, 54,000 mg/kg	Indust. SRV, STW SRV, (MPCA 1/99)
Benzo(a)anthracene	Sediments	78 mg/kg	Previous	78 mg/kg	
Benzo(a)anthracene	Sediments		New	1100 mg/kg	Crane and Others, 2000
Benzo(a)pyrene	Sediments	8 mg/kg	Previous	8 mg/kg	
Benzo(a)pyrene	Sediments		New	1500 mg/kg	Crane and Others, 2000
Chrysene	Sediments	784 mg/kg	Previous	784 mg/kg	
Chrysene	Sediments		New	1300 mg/kg	Crane and Others, 2000
Naphthalene	Sediments	None	Previous	None	
Naphthalene	Sediments		New	560 mg/kg	Crane and Others, 2000

Phenanthrene	Sediments	None	Previous	None	
Phenanthrene	Sediments		New	1200 mg/kg	Crane and Others, 2000
Lead	Sediments	None Available	Previous	None Available	ROD/AROD treated soils and sediments the same
Lead	Sediments	130 mg/kg	New	130 mg/kg	Crane and Others, 2000
Nickel	Sediments	None Available	Previous	None Available	
Nickel	Sediments		New	49 mg/kg	Crane and Others, 2000
Zinc	Sediments	None Available	Previous	None Available	
Zinc	Sediments		New	460 mg/kg	Crane and Others, 2000

Compound	**Media**	**Standard**	**Previous**	**MCL/HRL (RAL)**	
			New	**MCL/HRL (HBV)**	
Ground water Bromoform	Ground water	100 ug/L	Previous	100*/40 ug/L *TTHM	Federal Safe Drinking Water Act (SDWA), 1979 for total trihalomethanes (TTHMs) & MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Bromoform	Ground water		New	80*/40 ug/L *THM Sum	Federal SDWA, 12/1998, (THMs) Stage 1 & MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
2-Butanone	Ground water	No MCL	Previous	- / (300 ug/L)	MDH RAL, Jan. 1991
2-Butanone	Ground water		New	- / 4000 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93

Chlorodibrom omethane	Ground water	100* ug/L *THM Sum	Previous	100* / - ug/L *THM Sum	Federal SDWA, 1979 (TTHMs)
Chlorodibrom omethane	Ground water		New	80* / - ug/L *THM Sum	Federal SDWA, 12/1998, Stage 1 (TTHMs)
Chloroethane	Ground water	None Available	Previous	None Available	
Chloroethane	Ground water		New	- / 280 ug/L	MDH HBV, 8/11/00
Chloroform	Ground water	100 ug/L	Previous	100*/60 ug/L *THM Sum	Federal SDWA, 1979, (THMs) & MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Chloroform	Ground water		New	80*/60 ug/L *THM Sum	Federal SDWA, 12/98, Stage 1 & MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
1,1-DCA	Ground water	None Available	Previous	None Available	
1,1-DCA	Ground water		New	70 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94
1,2-DCE (cis)	Ground water	None Available	Previous	None Avail.	
1,2-DCE (cis)	Ground water		New	70 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94
1,2-DCE (trans)	Ground water	100 ug/L	Previous	100 / - ug/L	Federal SDWA, 1991, Phase II
		100 ;ug/L	New	100/100 ug/L	Federal SDWA, 1991, & MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94
Ethylbenzene	Ground water	700 ug/L	Previous	700 / - ug/L	Federal SDWA, 1991, Phase II
Ethylbenzene	Ground water	700 ug/L	New	700 / 700 ug/L	Federal SDWA, 1991, Phase II & MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93

Methylene Chloride	Ground water	No MCL	Previous	- / 50 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Methylene Chloride	Ground water	5 ug/L	New	5 / 50 ug/L	Federal SDWA, 7/92 & MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Tetrachloroethene	Ground water	5 ug/L	Previous	5/(7) ug/L	Federal SDWA, 1991, Phase 2
Tetrachloroethene	Ground water		New	5/7 ug/L	Federal SDWA, 1991, Phase II & MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94
Toluene	Ground water	1000 ug/L	Previous	1000 / - ug/L	Federal SDWA, 1991, Phase II
Toluene	Ground water	1000 ug/L	New	1000 / 1000 ug/L	Federal SDWA, 1991, Phase II & MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Total Xylenes	Ground water	10,000 (total)	Previous	10,000/ - ug/L	Federal SDWA, 1991, Phase II
Total Xylenes	Ground water	10,000 (total)	New	10,000/10,000 ug/L	Federal SDWA, 1991, Phase II & MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94
1,1,1-TCA	Ground water	200 ug/L	Previous	200 /- ug/L	Federal SDWA, 7/87
1,1,1-TCA	Ground water	200 ug/L	New	200/600 ug/L	Federal SDWA, 7/87 & MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94
1,1,2-TCE	Ground water	5.0 ug/L	Previous	5/(30) ug/L	Federal SDWA, 7/87, MDH RAL, Jan. 1991
1,1,2-TCE	Ground water	5.0 ug/L	New	5/(5) ug/L	Federal SDWA, 7/87, & MDH HBV
Vinyl Chloride	Ground water	2.0 ug/L	Previous	2.0/(0.1) ug/L	Federal SDWA, 7/87, MDH Recommended Allowable Limit (RAL), Jan. 1991
Vinyl Chloride	Ground water		New	2.0/0.2 ug/L	Federal SDWA, 7/87 & MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94

DRO +GRO	Ground water	None Available	Previous	None Available	
DRO + GRO	Ground water		New	200 ug/L	MDH HBV, 10/8/99 Advisory Level (pyrene used as surrogate)
4-Methylphenol	Ground water	No MCL	Previous	- / - ug/L	
4-Methyl phenol	Ground water	3 ug/L	New	- / 3 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94
Bis(2-ethylhexyl)phthalate	Ground water	6 ug/L	Previous	6 / - ug/L	Federal SDWA, 7/92
Bis (2-ethyl hexyl) phthalate	Ground water	6 ug/L	New	6/20 ug/L	Federal SDWA, 7/92 & MDH HBV, 11/4/97
Bromodichloromethane	Ground water	No MCL	Previous	- / 6 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Bromodichloromethane	Ground water		New	80*/6 ug/L *THM Sum	Federal SDWA, 12/98 (TTHMs) & MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Naphthalene	Ground water	No MCL	Previous	- / (30) ug/L	MDH RAL
Naphthalene	Ground water		New	- / 300 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94
Phenol	Ground water	No MCL	Previous	- / (4000) ug/L	MDH RAL, Jan. 1991
Phenol	Ground water		New	- / 4000 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Pyrene	Ground water	No MCL	Previous	- / (200) ug/L	MDH RAL, Jan. 1991
Pyrene	Ground water		New	- / 200 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94

Antimony	Ground water	6 ug/L	Previous	6/1 ug/L	Federal SDWA, 7/92 & MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Antimony	Ground water	6 ug/L	New	6/6 ug/L	Federal SDWA, 7/92 & MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Arsenic	Ground water	50 ug/L	Previous	50/0.2 ug/L	Federal SDWA 12/75 & MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94
Arsenic	Ground water	10 ug/L	New	10/- ug/L	Federal SDWA, 2001
Barium	Ground water	2000 ug/L	Previous	2000/- ug/L	Federal SDWA, 1/91
Barium	Ground water	2000 ug/L	New	2000/2000 ug/L	Federal SDWA, 1/91 & MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Chromium	Ground water	100 ug/L	Previous	100 ug/L	Federal SDWA, 1991, Phase II
Trivalent Chromium	Ground water	None Available	Previous	None Available	
Trivalent Chromium	Ground water		New	- / 20,000 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94
Hexavalent Chromium	Ground water	None Available	Previous	None Available	
Hexavalent Chromium	Ground water	None Available	New	- / 100 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Lead	Ground water	15 ug/L	Previous	15/(20) ug/L	Federal SDWA, 6/91, MDH RAL, Jan. 1991
Lead	Ground water	15TT ug/L	New	15TT/ - ug/L	Federal SDWA, 6/91
Lithium	Ground water	No MCL	Previous	None Avail.	
Lithium	Ground water		New	- / (200) ug/L	MDH HBV, 02/02/01

Manganese	Ground water	No MCL	Previous	- / 100 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94
Manganese	Ground water		New	- / 1000 ug/L	MDH HBV, 12/31/97
Mercury	Ground water	2 ug/L	Previous	2 / (1) ug/L	Federal SDWA, 1991, Phase II, MDH RAL, Jan. 1991
Mercury	Ground water		New	2 / - ug/L	Federal SDWA, 1991, Phase II
Nickel	Ground water	No MCL	Previous	- / 100 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Nickel	Ground water	100 ug/L	New	-/ 100 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Strontium	Ground water	No MCL	Previous	- / - ug/L	
Strontium	Ground water		New	- / (4000) ug/L	MDH HBV, 5/10/95
Thallium	Ground water	2 ug/L	Previous	2 / (3) ug/L	Federal SDWA, 7/92, MDH RAL, Jan. 1991
Thallium	Ground water		New	2 / 0.6 ug/L	Federal SDWA, 7/92 & MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94
Vanadium	Ground water	No MCL	Previous	- / (20) ug/L	MDH RAL, Jan. 1991
Vanadium	Ground water		New	- / 50 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94
Zinc	Ground water	No MCL	Previous	- / - ug/L	
Zinc	Ground water		New	- / 2000 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 12/5/94
Carcinogenic PAHs (as BaP Equivalents)	Ground water	None Available	Previous	None Available	
Carcinogenic PAHs (as BaP Equivalents)	Ground water		New	0.05 ug/L	MDH HBV, 12/15/95 Advisory Level

Acenaphthene	Ground water	None Available	Previous	None Available	
Acenaphthene	Ground water		New	400 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Anthracene	Ground water	None Available	Previous	None Available	
Anthracene	Ground water		New	2000 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Fluoranthene	Ground water	None Available	Previous	None Available	
Fluoranthene	Ground water		New	300 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Fluorene	Ground water	None Available	Previous	None Available	
Fluorene	Ground water		New	300 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93
Pyrene	Ground water	None Available	Previous	None Available	
Pyrene	Ground water		New	200 ug/L	MDH HRL, MN Rules 4717.7100 – 4717.7800, 11/22/93

Where an updated soil or ground water standard is available, MPCA staff calculated if the old cleanup level continues to fall within the 10^{-4} to 10^{-6} risk range as required in Exhibit G-3, on Page G-6 of the EPA Five Year Review Guidance. A summary of this information is provided in Table 4B below. The approach provided by the EPA in the 1994 Amended ROD does not work for sediments as the equations are not the same. Therefore, they are not listed in Table 4B below, but new sediment Tier 2 SQTs, as sediment screening numbers, are compared to maximum concentrations prior to excavation in Table 4C.

Table 4B. Changes in Risk using the 1994 AROD Cleanup Numbers

Contaminant	Media	1994 Amend. ROD Cleanup Level (mg/kg)	Hazard Quotient (HQ)	Excess Life. Cancer Risk	Outside 10-4 to 10-6 Risk Level or HQ>1?
Benzene	Soils	1,974	98.7	1.97E-3	Yes
2-Butanone	Soils	1.23E6	57.2	NA	Yes
Carbon Tetrachloride	Soils	440	97.778	9.78 E-4	Yes, but excavated, and ND in ground water
Chloroform	Soils	2.04E4	20.4	5E-2	Yes
1,2-Dichloroethane	Soils	629	10.483	1.05E-3	Yes, but excavated, and ND in ground water
Methylene Chloride	Soils	1,23E5	15.570	7.78E-3	Yes
Trichloroethene	Soils	5,203	NA	1.13E-3	Yes
Benzo(a)anthracene	Soils	78		See cPAHs	Yes for total BaP Equiv.
Benzo(a)pyrene	Soils	8		See cPAHs	Yes for total BaP Equiv.
Benzo(b)fluoranthene	Soils	78		See cPAHs	Yes for total BaP Equiv.
Benzo(k)fluoranthene	Soils	784		See cPAHs	Yes for total BaP Equiv.
Butylbenzylphthalate	Soils	4.09E5	22.108	NA	Yes
Chrysene	Soils	784		See cPAHs	Yes for total BaP Equiv.
Dibenz(a,h)anthracene	Soils	8		See cPAHs	Yes for total BaP Equiv.
Dibenzofuran	Soils	6,176	1.525	NA	Yes
Fluorene	Soils	8.24E4	3.981	NA	Yes
Phenol	Soils	1.22E6	9.104	NA	Yes
Pyrene	Soils	6.13E4	2.110	NA	Yes
Bromoform	Ground water	100 ug/L Sum TTHM		2.5E-5	No
2-Butanone	Ground	300 ug/L			No

	water				
Chlorodibrom omethane	Ground water	100 ug/L Sum TTHM		2.5E-5	No
Chloroform	Ground water	100 ug/L Sum TTHM		2.5E-5	No
Arsenic	Ground water	50 ug/L		2.5E-3	Yes

A summary of the new standards, TBCs, and Tier 2 SQTs is provided in Table 4C. The new standards and TBCs are based on:

- the old standard or TBC falling outside the 10-4 to 10-6 risk range;
- the old standard having a hazard quotient greater than one, or
- a new standard or TBC being generated since the last Five Year Review.

In Table 4C, MPCA staff compared the new standards, TBCs, and SQTs to the maximum concentrations detected at the Site for soils and sediments prior to excavation, as listed in the 1994 Amended ROD. MPCA staff assumes that the maximum concentrations listed in the 1994 Amended ROD are correct.

Table 4C. Maximum Concentrations and New TBCs

Contaminant	**Media**	**Max. Conc. Detected**	**New TBC Cleanup Number**	**Is New TBC Cleanup Number Exceeded by Max. Conc. Prior to Excavation?**	**Verification Samples**
Benzene	Soils	0.6 mg/kg	4 mg/kg industrial SRV	No	NA
2-Butanone	Soils	0.43 mg/kg	1240 mg/kg STW SRV	No	NA
Carbon Tetrachloride	**Soils**	**6.4 mg/kg, Per Table D-6 in FDI, April 30, 1990.**	**0.9 mg/kg industrial SRV**	**Yes**	**Visual**
Chloroform	Soils	2.4 mg/kg	4 mg/kg industrial SRV	No	NA
Dibenzofuran	Soils	4.4 mg/kg	810 mg/kg industrial SRV	No	NA
1,2-Dichloroethane	**Soils**	**310 mg/kg**	**6 mg/kg industrial & STW SRVs**	**Yes**	**Visual**
Methylene Chloride	Soils	21 mg/kg	158 mg/kg industrial &	No	NA

			STW SRVs		
Trichloroethene	Soils	2.5 mg/kg	46 mg/kg, industrial & STW SRVs	No	NA
Benzo(a)anthracene	Soils	39 mg/kg	See cPAHs		Visual
Benzo(a)pyrene	Soils	21 mg/kg	See cPAHs		Visual
Benzo(b)fluoranthene	Soils	35 mg/kg	See cPAHs		Visual
Benzo(k)fluoranthene	Soils	35 mg/kg	See cPAHs		Visual
Chrysene	Soils	20 mg/kg	See cPAHs		Visual
Dibenz(a,h)anthracene	Soils	4.7 mg/kg	See cPAHs		Visual
Carcinogenic. PAHs (cPAHs)	Soils		4 mg/kg BaP Equivalents industrial SRV	Yes	Visual
Bis(2-ethylhexyl)phthalate	Soils	2.1 mg/kg	2100 mg/kg industrial SRV	No	NA
Butylbenzylphthalate	Soils	1.9 mg/kg	3700 mg/kg industrial SRV	No	NA
Fluorene	Soils	15 mg/kg	4,120 mg/kg industrial SRV	No	NA
Naphthalene	Soils	22 mg/kg	28 mg/kg industrial SRV	No	NA
Phenol	Soils	0.39 mg/kg	15,070 mg/kg STW SRV	No	NA
Pyrene	Soils	46 mg/kg	5800 mg/kg industrial SRV	No	NA
Aluminum	Soils	8,997 mg/kg	100,000 mg/kg industrial SRV	No	NA
Antimony	Soils	51 mg/kg	100 mg/kg industrial & STW SRV	No	NA
Beryllium	Soils	7.8 mg/kg	290 mg/kg industrial SRV	No	NA
Cobalt	Soils	21 mg/kg	3,000 mg/kg	No	NA

			industrial SRV		
Copper	Soils	24 mg/kg	9,000 mg/kg industrial & STW SRV	No	NA
Mercury	Soils	0.6 mg/kg	0.7 mg/kg STW SRV	No	NA
Nickel	Soils	83 mg/kg	3,000 mg/kg industrial & STW SRV	No	NA
Vanadium	Soils	70 mg/kg	1,340 mg/kg industrial & STW SRV	No	NA
Zinc	Soils	875 mg/kg	54,000 mg/kg STW SRV	No	NA
Benzo(a)anthracene	Sediments	0.35 mg/kg	1100 mg/kg	No	NA
Benzo(a)pyrene	Sediments	0.33 mg/kg	1500 mg/kg	No	NA
Chrysene	Sediments	0.34 mg/kg	1300 mg/kg	No	NA
Naphthalene	Sediments	6.6 mg/kg	560 mg/kg	No	NA
Phenanthrene	Sediments	6.6 mg/kg	1200 mg/kg	No	NA
Lead	**Sediments**	**499 mg/kg**	**130 mg/kg**	**Yes, before cleanup. Verification samples collected.**	**Analytical for wastewater ditch and lagoon**
Nickel	**Sediments**	**71 mg/kg**	**49 mg/kg**	**Yes**	**None**
Zinc	**Sediments**	**1,630 mg/kg**	**460 mg/kg**	**Yes**	**None**

Contaminant	Media	Present Ground Water Concentration, or GW Conc. At Earlier Time (Specify) if no Present GW Concentration	New Ground Water TBC Number	Is New Ground Water TBC Number Exceeded?	Where Exceeding?
2-Butanone	Ground water	<10 ug/L	4000 ug/L	No	NA
Chloroethane	Ground water	0.8 ug/L	280 ug/L	No	NA
1,1-Dichloroethane	Ground water	P<0.2 ug/L	70 ug/L	No	NA
Cis-1,2-Dichloroethene	Ground water	5.5 ug/L	70 ug/L	No	NA
1,4-Dioxane	**Ground water**	**Not Sampled to Date – New Request from MDH**	**30 ug/L**	**Unknown,**	**Unknown if exceeding. Verification sampling planned for on-site wells in October 2002.**
Methylene Chloride	Ground water	0.6 ug/L	5 ug/L	No	NA
DRO+GRO	**Ground water**	**170 to 380 ug/L**	**200 ug/L**	**Yes periodically**	**GW Sampling at MPCA-4A**
4-Methylphenol	**Ground water**	**Not Analyzed** **400 ug/L in AROD**	**3 ug/L**	**Not Analyzed**	**Unknown if exceeding. For verification collect samples at MPCA-4A, MPCA-5A, MW-14A, MW-3S, and discharge**
Naphthalene	Ground water	<0.5 ug/L	300 ug/L	No	NA
Phenol	Ground water	400 ug/L in AROD	4000 ug/L	No	NA

Arsenic	**Ground water**	**Not Analyzed**	**10 ug/L**	**Not Analyzed**	**Unknown if exceeding. For verification, collect samples at MPCA-4A and discharge**
Trivalent Chromium	Ground water	Total Chromium 290 ug/L in AROD	20,000 ug/L	No	NA
Hexavalent Chromium	**Ground water**	**Total Chromium 290 ug/L in AROD**	**100 ug/L**	**Not Analyzed**	**Unknown if exceeding. For verification, collect samples at MPCA-4A and discharge**
Lithium	Ground water	20 ug/L in AROD	200 ug/L	No	NA
Manganese	Ground water	1.4 ug/L	1000 ug/L	No	NA
Strontium	Ground water	202 ug/L in AROD	4000 ug/L	No	NA
Vanadium	**Ground water**	**505 ug/L in 1994 AROD**	**50 ug/L**	**Possibly**	**Unknown if exceeding. For verification collect sample at MPCA-4A and discharge**
Zinc	**Ground water**	**295,000 ug/L in 1994 AROD**	**2000 ug/L**	**Not Analyzed**	**Unknown if exceeding. For verification, collect sample at MPCA-4A and discharge**
Carcinogenic PAHs	Ground water	0.021 to 0.002 ug/L, MW-16S, (3/3/97) and discharge	0.05 ug/L	No	NA
Acenaphthene	Ground water	<0.010 ug/L 10/96+3/97 sampling events	400 ug/L	No	NA
Anthracene	Ground water	<0.010 ug/L 10/96+3/97 sampling events	2000 ug/L	No	NA

Fluoranthene	Ground water	0.052 ug/L, MW-16S (3/3/97)	300 ug/L	No	NA
Fluorene	Ground water	0.049 ug/L, MPCA-4a (6/26/97)	300 ug/L	No	NA
Pyrene	Ground water	0.044, MW-16S (3/3/97)	200 ug/L	No	NA

There are no changes in action-specific or location-specific requirements.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There are no impacts from natural disasters. No other information is known that could affect the protectiveness of the remedy.

Technical Assessment Summary

The three phases were evaluated for changes in chemical-specific, action-specific and location-specific changes in Applicable or Relevant and Appropriate Requirements (ARARs) and other Site physical characteristics. All known applicable files were reviewed. A Site inspection and Site interviews were conducted. At the Site inspection, any changes from the as-built Site close-out reports were compared to the Site's existing condition.

To determine whether the remedy for the Soils and Sediments Phase was functioning as intended by the decision documents, MPCA staff evaluated the cleanup and its objectives. The MPCA staff inspected the Site. The drainages at the Site have been somewhat altered as the EPA ditch was connected on the north side of the Site with a county ditch on the Site's western boundary. The EPA ditch was supposed to start on the northern side of the Site, flow to the east, next to the south along the Site's eastern boundary, and then, along the southern boundary, to the west to a culvert along Highway 53. In addition, two swales exist that are outside of the final elevations maps, which drain the west and southwest sides of the Site directly to the western county ditch and to the EPA ditch on the southwest side. Also, two settled areas were found that need to be brought up to final grade as shown in the CH2M Hill 1997 Soils and Sediments Close-Out Report. The culvert north of Highway 53 is blocked and water is backing up in the ditches to the Site. MPCA staff recommends that a water drainage plan be prepared to address the sediment and drainage issues. Finally, a draft copy of the restrictive covenant is included as Appendix 7 to the five-year review. The restrictive covenant needs to be finalized by MPCA staff and filed by St. Louis County.

To answer Question A for Ground Water, MPCA staff provided a summary of information about the excellent mechanical performance and very reliable French Drain extraction system. Flow volumes are measured and reported monthly to WLSSD. With a couple of exceptions, the flow volumes fall within the range of 700,000 to 1,400,000 million gallons per day (mgd). The reduced flow volumes were due to a short in the electrical system that needed rewiring and when WLSSD was experiencing sewer overflows during high precipitation events. The system was always restarted by MPCA's contractor within no more than a three day time period.

The WLSSD issue regarding overflows was resolved with the expansion of its plant. In addition, the hydraulic containment is working as designed as shown on the ground water contour map and by the water level summary information provided in Attachments 4 and 5.

Also, MPCA staff provided a list of all current ground water monitoring well exceedances, the rates of ground water cleanup, and documentation that the discharge water easily meets all WLSSD discharge requirements. Ground water was found to be naturally attenuating much faster than expected and is expected to meet all cleanup numbers within 4 to 8 years, if left to naturally attenuate by itself. An estimate of 25 to 50 years was originally projected at the time of the 1994 AROD. At present, vinyl chloride is exceeded only in the extraction system discharge with concentrations 2 to 10 times the MCL and in monitoring well MW-14A with concentrations at approximately the MCL. The discharge also occasionally exceeds the lead at the tap standard of 15 ug/L, likely due to soil particles getting into the sample bottle, and analyzing the lead as total without filtration. It is proposed to perform four quarters of sampling of the discharge for dissolved and total lead to resolve this issue. Also, well MPCA-4A occasionally exceeds the DRO and GRO cleanup criterion of 200 ug/L. However, neither the extraction system discharge nor any other monitoring well exceeds this criterion and, with the deed restrictions, this exceedance will not be an issue with regard to being protective of human health and the environment for the present and future.

In an attached August 26, 2002 memorandum, MPCA staff recommends continuing the pumpout system operation and allowing the ground water at the Site to naturally attenuate without supplementation. In this memo, MPCA staff also provides specific recommendations for reductions in ground water monitoring frequency and for natural attenuation monitoring for the Site.

To Answer Question B, MPCA staff assembled the pertinent new TBC levels and policies and summarized changed or new TBC levels in Table 4A. The new risks associated with the old cleanup numbers that had changed were re-calculated in Table 4B. Next, any new TBC levels that resulted from the work documented in Tables 4A and 4B were summarized in Table 4C. Table 4C also includes, for soils, a comparison of new TBC levels to maximum concentrations listed in the 1994 AROD. For sediments, all Tier 2 SQTs that were exceeded are summarized. For ground water, the final cleanup numbers were compared to the most recent concentrations.

For the source materials Phase, excavation was complete and the Phase is closed. There are no known issues with regard to this Phase.

For the soils and sediments Phase, the Tier 2 SQT for lead is 130 mg/kg in the St. Louis River Basin, of which the EPA ditch is a part. The Tier 2 SQT is found within Tables 14 and 15 of "Development of a Framework for Evaluating Numerical Sediment Quality Targets and Sediment Contamination in the St. Louis River Area of Concern." The website for this document is http://hubble.pca.state.mn.us/water/sediments/studies-stlouis.html. The lead cleanup remedial action objective was to excavate, stabilize and dispose of soils above 500 mg/kg for the Site. The EPA ditch was sampled twice during the Remedial Investigation and lead concentrations directly south of the Gopher Oil Building and at two locations downstream of it exceeded the 130 mg/kg lead screening Tier 2 SQT. The EPA ditch was not re-sampled as part of CH2M Hill's Fieldwork Design Investigation. It also was never excavated. MPCA staff recommends that an evaluation be performed of potential impacts to aquatic organisms in the

sediments of the EPA ditch south of the Gopher Oil Building downstream to the culvert north of Highway 53.

The AROD was finalized in February 1994 using RALs for ground water TBCs or ARARs. Soon after, the MDH replaced the advisory RALs with promulgated HRLs in December 1994. At that time, the MDH promulgated the HRLs as Minnesota Rules 4717.7100 to 4717.7800. Since 1994, additional HRLs were added and the MDH issued HBVs, which are TBC criteria for several contaminants. Many of these contaminants with HBVs do not have MCLs or HRLs. Their basis is usually found in the EPA database IRIS, and the method of calculation is the same as for MCLs' health calculations, except MDH uses a strict 10^{-5} risk level.

MPCA staff recommends conducting, in October 2002, a one time confirmatory sampling at well MPCA-4A and the extraction system discharge for the metals arsenic, hexavalent chromium, vanadium, and zinc as well as zinc in well MW-14S. Based on a comparison of the new TBC numbers for these four metals and the maximum concentrations in the 1994 AROD, the old 1994 AROD maximum concentrations exceed the new TBC numbers in former on-site well B4a, next to the lagoon and on-site well MW-14S for zinc only. Well B4a was removed upon excavation of the source areas and soils and sediments. MPCA staff recommends conducting this sampling since these changes in TBC numbers have occurred and because confirmatory samples were never collected since the source area and soil and sediment cleanup occurred in 1995 and 1996. The 1994 AROD concentrations for these four metals are the most recent data.

MPCA staff also recommends that ground water samples be collected and analyzed for SVOCs to confirm that 4-methylphenol is not above the new HRL of 3 ug/L. The water samples will be collected from wells MPCA-4A, MPCA-5A, MW-14S, MW-3S, and the extraction system discharge in October 2002. As is the case with the metals, the most recent data is the 1994 AROD maximum concentrations and confirmatory results are needed.

MPCA staff recommends collecting four quarters of dissolved and total lead discharge data from the extraction system discharge to resolve whether lead is moving through the ground water or is only particulates.

The MDH has recently issued an HBV for 1,4 dioxane. This compound has been reported to be closely associated with trichloroethene and is very water soluble. In October 2002, MPCA staff proposes collecting ground water samples from on-site wells and the discharge for 1,4-dioxane. Given that trichloroethene has only been found in very low concentrations that do not exceed the 5 ug/L cleanup level at the Site, detection of 1,4-dioxane is not expected above the 30 ug/L HBV.

With regard to changes in exposure pathways under Question B, there have been no changes in land use, which remains zoned as industrial / restricted commercial and is used for a warehouse and as open land. There are no other changes to human health or ecological routes of exposure other than those discussed above. There are no newly identified contaminants or contaminant sources or unanticipated toxic byproducts except as noted above in Question B. The physical conditions that have changed at the Site are those for surface water drainages and they are discussed in Questions A and B above.

Changes in toxicity and other contaminant characteristics are limited to the changes discussed in Question B. Changes in Risk Assessment Methods are limited to carcinogenic PAHs and sediment TBC numbers. Carcinogenic PAHs are not a concern at the Site in any media, given the new or old numbers. Sediment ecological screening numbers were recently developed in 2001, and they are calculated differently from soils cleanup levels (reference the St. Louis River sediments website listed previously). New sediment information is still being generated. Potential impacts to aquatic organisms may be an issue for lead sediment concentrations in the EPA ditch south of the Gopher Oil Building and downstream of it to the culvert on the north end of Highway 53.

With regard to Question C, there are no newly identified ecological risks except those previously discussed above. There are no impacts from natural disasters, or any other information than that already presented, that may affect the protectiveness of the remedy.

VIII. Issues

1. The Consent Decree, restrictions and access agreements were not completed and filed pursuant to the Consent Decree in 1995. Draft restrictions need to be finalized by MPCA staff and filed at the St. Louis County Recorder's Office as a restrictive covenant. Action needs to be taken on remaining issues 2 and 3, stated below, so that the restrictions can be finalized.

2. Settlement and changes in drainage are occurring

3. The potential exists for aquatic organisms to be affected by the lead in sediments of the EPA ditch south of the former Gopher Oil Building, now HOM warehouse, and downstream of it to the culvert on the north side of Highway 53.

4. No confirmatory sampling was conducted at on-site wells after the 1996 excavation, treatment and disposal of source materials and soils and sediments which contained arsenic, hexavalent chromium, vanadium, zinc, and 4-methylphenol; 4-methylphenol has a new more restrictive Minnesota Department of Health (MDH) Health Risk Limit (HRL) of 3 ug/L.

5. The current lead analysis method does not determine whether dissolved lead is moving with ground water.

6. 1,4-dioxane, a compound recently recognized to be closely associated with trichloroethene, has a new MDH Health Based Value (HBV) of 30 ug/L.

Issue 3 (Lead in sediments) may affect current ecological protectiveness. Any of the issues may affect future protectiveness.

IX. Recommendations and Follow-up Actions

Table 8: Recommendations and Follow-up Actions

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Mile-stone Date	Affects Future Protectiveness (Y/N)	
					Current	Future
1. Consent Decree, restrictions, and access agreements are not filed at the Recorder's office.	Assure Consent Decree is filed; assure access for MPCA staff; determine which parcels need restrictions, finalize restrictions, file restrictive covenant.	MPCA	EPA	December, 2003	No	Yes
2. Settlement and drainage	Evaluate and if necessary: a.) Bring settled areas to final grade. b.) Prepare a drainage plan. c.) Repair the plugged culvert north of Highway 53	MPCA /EPA	EPA	December, 2004	No	Yes
3. Potential impact to biota in sediments .	Sample sediments to determine the potential impact to aquatic organisms from lead in sediments above the 130 mg/kg Tier 2 SQT sediment screening levels in the EPA ditch south of the Gopher Oil Building and downstream from it to the culvert north of Highway 53.	EPA/MPCA	MPCA	December 2004	Yes need information to determine environmental risk	Yes

4. Lack of confirmatory ground water sampling	Perform confirmatory sampling for arsenic, hexavalent chromium, zinc, vanadium, from well MPCA-4A and the extraction system discharge, zinc from MPCA-14S, and 4-methylphenol (SVOCs) from wells MPCA-4A, MPCA-5A, MW-3S, MW-14A, and the extraction system discharge, compare with the current standards and numbers.	MPCA	EPA	December 2004	No, have containment	No, if above ground water clean-up numbers, affects time for ground water clean-up.
5. Sporadic total lead exceedances in the discharge of the 15 ug/L at the tap number may indicate migration with ground water.	Collect four consecutive quarters of dissolved and total lead discharge samples to show lead is not in dissolved sample.	MPCA	EPA	2004	No, have containment.	Yes, if found to be actually migrating with ground water.
6. 1,4-dioxane has a revised groundwater standard (HBV of 30 ug/L).	Ground water sampling of source area (on-site) wells and the extraction system discharge for 1,4-dioxane to determine if any concentrations exceed the HBV of 30 ug/L.	MPCA	EPA	October 2002	No, have containment.	No, if above HBV, may affect time for ground water cleanup.

X. Protectiveness Statements

Source Materials Phase

The source materials remedy is protective of human health and the environment because the threats presented by this media have been addressed through excavation, treatment and disposal off-site in a permitted RCRA Subtitle D facility.

Soil and Sediment Phase

A protectiveness determination of the soils and sediments phase remedy at the Site cannot be made at this time until further information is obtained. However, in the short-term, the removal of the contaminated soils and sediment and the current land use are protective of human health. Further information will be obtained by taking the following actions:

- Evaluate potential impacts to aquatic organisms which may be occurring due to lead in sediments of the EPA ditch south of the Gopher Oil Building and downstream of it to the culvert, exceeding the lead Tier 2 SQT of 130 mg/kg.
- Evaluate and, if necessary, bring the settled areas on the Site to final grade and establish a surface water drainage plan, including addressing the plugged culvert north of Highway 53 and downstream of the Site.
- Finalize and file the deed restrictions.

It is expected that these actions will be completed by December 2004, at which time a protectiveness determination will be made.

Ground Water Phase

The ground water remedy at the Site is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled. At present:

- contaminated ground water is being contained on-site;
- there are no current receptors; and
- the ground water is being discharged to the WLSSD sanitary sewer within the volumes and discharge quality that is required under the WLSSD permit agreement.

Long-term Protectiveness

The source materials remedy has been completed and should remain protective. The ground water phase should also remain protective since contaminated ground water is being contained on-site and cleanup levels should be attained within the next 4-8 years. For the soil and sediment phase, protectiveness should be achieved after the recommendations above have been implemented. The current schedule to complete these recommendations is December 2004.

XI. Next Review

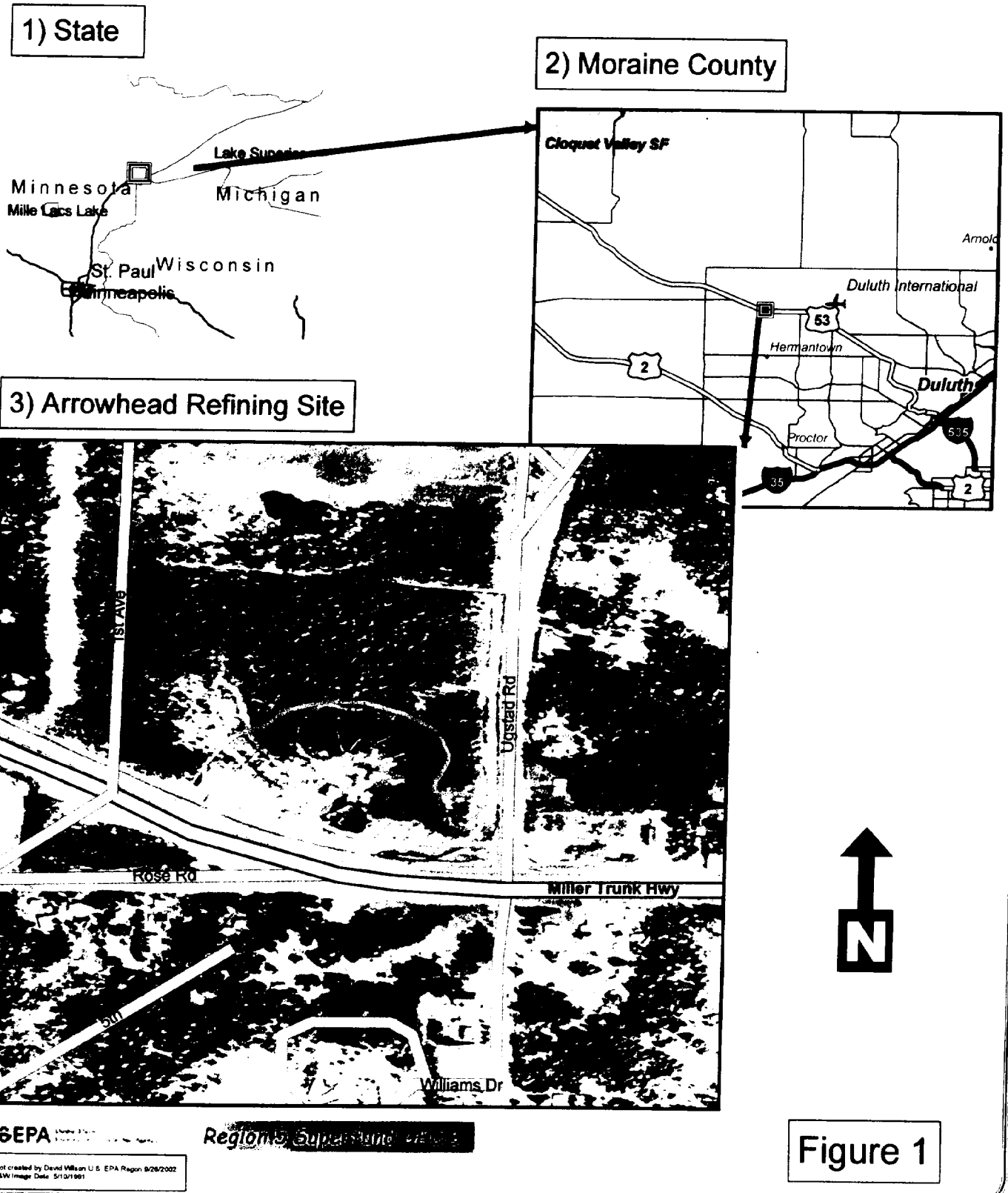
The next five-year review will be conducted by September 30, 2007, five years from the date of this review.

The next five-year review and future reviews will be conducted regardless of whether the Site is delisted from the NPL because the soils cleanup level is an industrial standard of 500 mg/kg for lead. Lead at this level is a hazardous substance, pollutant or contaminant that remains at the Site above levels that allow for unlimited use and unrestricted exposure. Delisting of the Site is anticipated in 2006 if the delisting criteria are met, including reduction of vinyl chloride in groundwater to its cleanup level.

Attachments

Attachment 1 - Site Map Showing Legal Descriptions
Attachment 2 - List of Documents Reviewed
Attachment 3 – Five-Year Review Inspection Record, Checklist, Map, and Photographs
Attachment 4 – Discharge Volume Summary Chart
Attachment 5 – Ground Water Elevations
Attachment 6 - Memorandum, August 26, 2002, Arrowhead Refinery Natural Attenuation Site Status
Attachment 7 - Draft Restrictive Covenant

Arrowhead Refining Superfund Site

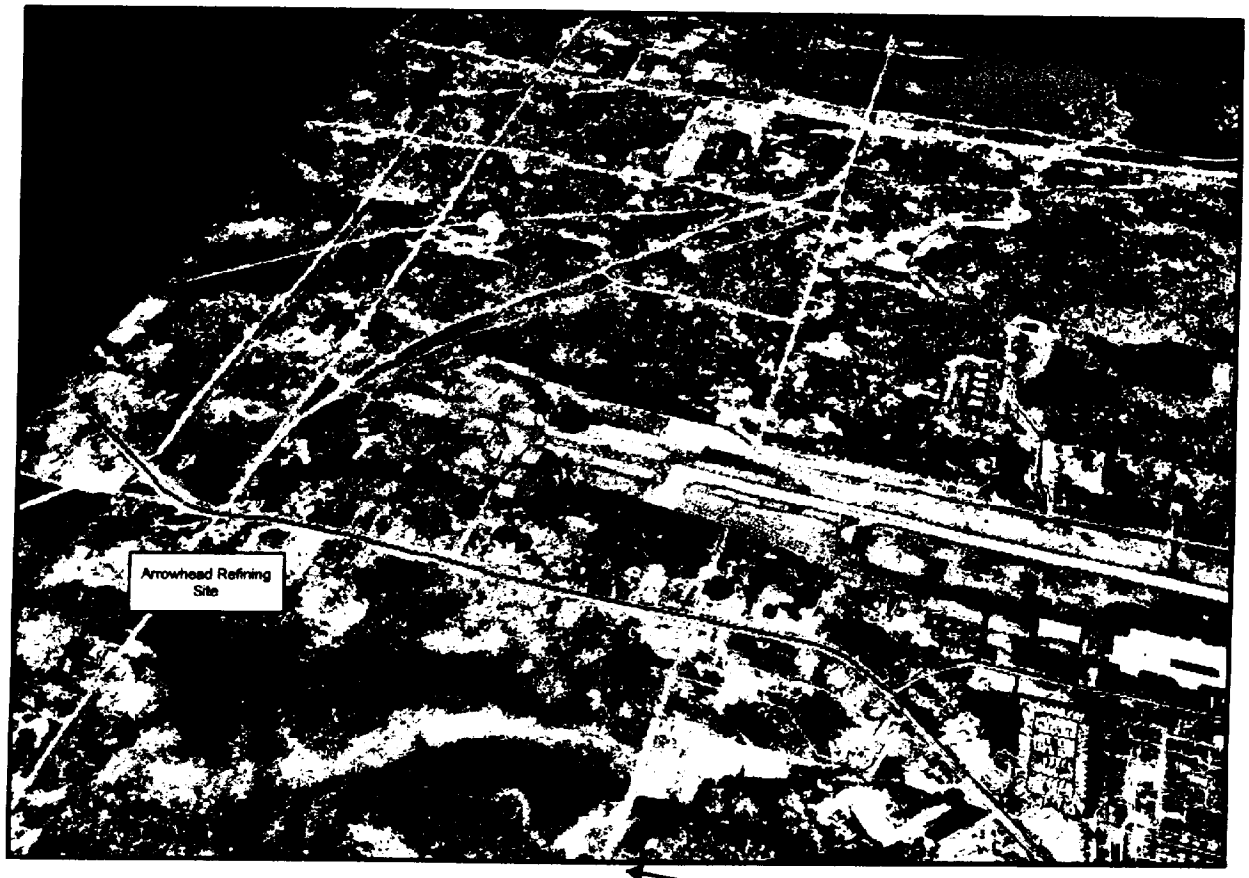


EPA Region 5 Superfund

Plot created by David Wilson U.S. EPA Region 9/26/2002
B&W Image Date: 5/10/1991

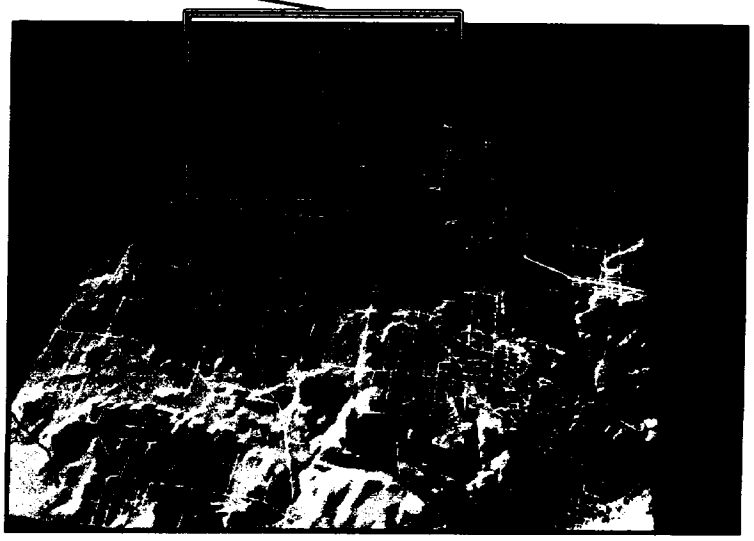
Figure 1

Arrowhead Refining Superfund Site
3D Surface Terrain Model



Elevation Feet

- 1397 - 1497
- 1297 - 1397
- 1198 - 1297
- 1098 - 1198
- 998 - 1098
- 899 - 998
- 799 - 899
- 699 - 799
- 600 - 699



N

Figure 2

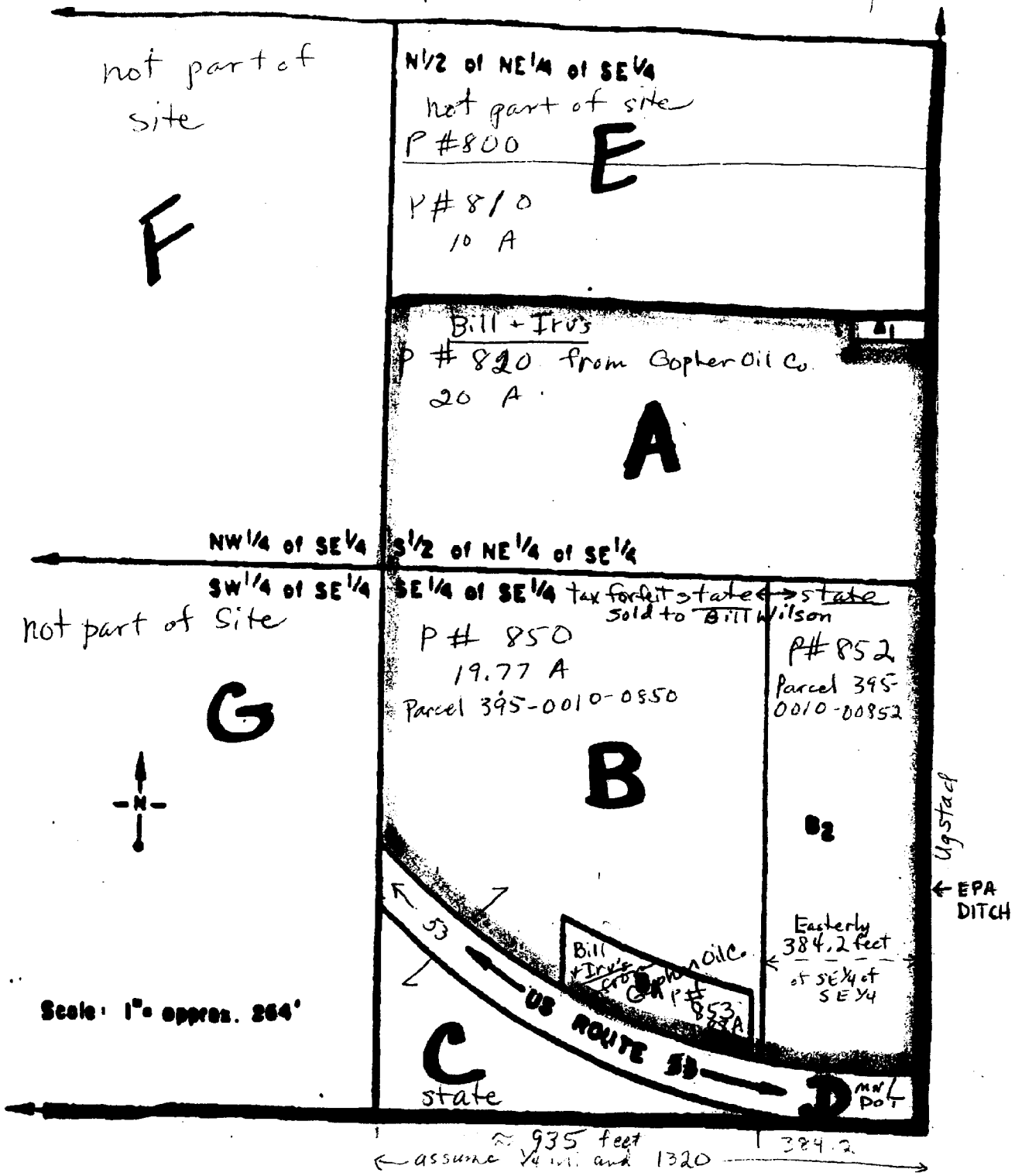
EPA Region 5 Superfund

Plot created by David Wilson U.S. EPA Region 5 on 9/26/2002
B&W Image Date 5/10/1991

Appendix C

ATTACHMENT 1

T50N R15W S4



Arrowhead Refining Site
Includes Parcels A, B, B1 and B2; and excludes Parcels A1, C, D, E, F, and G.

The base site map is from the ROD. Typewritten on base map is from Consent Decree.

ATTACHMENT 2
LIST OF DOCUMENTS REVIEWED

General / Historical

1. United States Environmental Protection Agency, February 9, 1981, The Arrowhead Refining Company Oil Spill On-Scene Coordinator's Report.
2. United States Environmental Protection Agency Region 5, September 15, 1986, Transcript of Public Meeting, Arrowhead Superfund Site, Hermantown High School.

Basis for the Response Action

3. ROD, 1986, and Responsiveness Summary
4. ROD amendment, 1994, and Responsiveness Summary
5. Federal Environmental Laws and Regulations
6. State Laws and Regulations
7. Remedial Action Plan, 1990
8. CH2M Hill, August 25, 1986, Remedial Investigation Report, Arrowhead Refinery Site, Hermantown, Minnesota, Volumes 1 and 2.

Implementation of the Response

9. CH2M Hill, April 30, 1990, Fieldwork Design Investigation, Arrowhead Refinery Site, Hermantown, Minnesota, Volumes 1-3.
10. Remedial Action Completion Report, Source Materials, MASC, May 21, 1997
11. 7-7, Inc. and Service Environmental Engineering, December 23, 1996, Completion of Remedial Action Report Completion of Work Report for the Arrowhead Refinery Site
12. CH2M Hill, November 1996, Phase I Residuals, Phase II Contaminated Soils and Sediments, Remedial Action Closure Report, Arrowhead Refinery Site, Hermantown, Minnesota
13. Barr Engineering Company, December 1991, Remedial Action Implementation Report, Water Main Extension and Well Abandonment, Arrowhead Refinery Site.
14. Preliminary Close Out Report, EPA, Dec. 19, 1996
15. Site Review & Update, MDH, November 21, 1996
16. ATSDR, September 23, 1993, Public Health Assessment for Arrowhead Refinery Company, Hermantown, St. Louis County, Minnesota.
17. Barr Engineering Company, December 17, 1990, Residential Well Abandonment Report.

Remedy Performance

18. Minnesota Pollution Control Agency, Monitoring Information Files by year.
19. Minnesota Pollution Control Agency, Monitoring Electronic files.
20. Minnesota Pollution Control Agency, September 20, 1997, Five-Year Review Report, Arrowhead Refining Company Superfund Site, Hermantown, Minnesota.
21. Annual Reports, 1996-1997, 1997-1998, April 1998 to February 2000, February 2000 through March 2001, 2001

O&M

22. PRC Environmental Management, Inc., July 24, 1995, Groundwater Remediation System Long-Term Remedial Action Operations and Maintenance Work Plan, Arrowhead Refinery.
23. Barr Engineering Company, July 1995, Groundwater Extraction System, Operations and Maintenance Manual, Arrowhead Refinery Site, Hermantown, Minnesota.
24. O&M Contracts, Delta Environmental Consultants, Inc. and RREM, Inc.
25. O&M & Occupational Safety and Health Agency (OSHA) training records
26. Service Agreement Compliance Reporting
27. Western Lake Superior Sanitary District Service Agreement
28. Access Agreement, MNDOT Right-of-Way permit
29. Security Logs
30. O&M Reports
31. Annual Reports, 1996-1997, 1997-1998, April 1998 to February 2000, February 2000 through March 2001, 2001.

Legal Documentation

32. Consent Decree
33. EPA Unilateral Order, March 1990, for water main and ground water extraction and treatment system
34. Institutional Controls: Draft Conditions, Covenants, or Restrictions on Deeds
35. Institutional Controls: Ground Water Use Restriction application to MDH
36. Institutional Controls: Land Use Restriction -- Zoning
37. Superfund State Contract
38. Cooperative Agreement, V005794-01

Community Involvement

39. RD/RA Community Relations Plan

ATTACHMENT 3
SITE INSPECTION: CHECKLIST, SUPPLEMENT, MAP, AND PHOTOGRAPHS

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION

Site name: Arrowhead Refinery Co.	**Date of inspection:** July 29, 2002
Location and Region: Hermantown, MN EPA R5	**EPA ID:** MND980823975
Agency, office, or company leading the five-year review: MPCA	**Weather/temperature:** Sunny, 75°F

Remedy Includes: (Check all that apply)

- Landfill cover/containment
- Access controls
- ✓ Institutional controls
- ✓ Groundwater pump and treatment
- ✓ Surface water collection and ~~treatment~~ routing
- Other Removal, trtmt, landfill of source materials; alternate water supply; Removal, stabilization, landfill soils+sediments > 500 ppm lead, backfill, soil cover
- Monitored natural attenuation
- ✓ Groundwater containment
- Vertical barrier walls

Attachments: Inspection team roster ~~attached~~ below ✓ Site map attached ✓ Record Supplement

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Keith Knoke (Name) Consultant project manager (Title) June-Aug. 2002 (Date)
   Interviewed at site at office ✓by phone Phone no. 651-697-5188
   Problems, suggestions; Report ~~attached~~ answered questions about the site.

2. **O&M staff** Karen Thole (Name) Consulant hydrogeologist (Title) June-Aug 2002 (Date)
   Interviewed at site at office ✓by phone Phone no. 651-697-5188
   Problems, suggestions; ~~Report attached~~ answered questions about the site

3. Current Owner of site property, reported in Five-Year Review Report.

Inspection team:
Maureen Johnson, Project Manager, MPCA
Barbara Gnabasik, Hydrogeologist, MPCA

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

O&M manual	Readily available	Up to date via annual report	N/A
As-built drawings	Readily available	Up to date	N/A
Maintenance logs	Readily available	Up to date	N/A

Remarks O+M manual will be consolidated with annual report amendments.

2. **Site-Specific Health and Safety Plan**

	Readily available	Up to date	N/A
Contingency plan/emergency response plan	Readily available	Up to date	N/A

Remarks

3. **O&M and OSHA Training Records** — Readily available — Up to date — N/A

Remarks

4. **Permits and Service Agreements**

Air discharge permit	Readily available	Up to date	N/A
Effluent discharge	Readily available	Up to date	N/A
Waste disposal, POTW	Readily available	Up to date	N/A
Other permits MNDOT, MNDNR	Readily available	Up to date	N/A

Remarks

5. **Gas Generation Records** — Readily available — Up to date — N/A

Remarks

6. **Settlement Monument Records** — Readily available — Up to date — N/A

Remarks

7. **Groundwater Monitoring Records** — Readily available — Up to date — N/A

Remarks

8. **Leachate Extraction Records** — Readily available — Up to date — N/A

Remarks

9. **Discharge Compliance Records**

Air	Readily available	Up to date	N/A
Water (effluent)	Readily available	Up to date	N/A

Remarks

10. ~~Daily~~ Weekly Access/Security Logs — Readily available — Up to date — N/A

Remarks

IV. O&M COSTS

1. **O&M Organization**
   State in-house — Contractor for State
   PRP in-house — Contractor for PRP
   Federal Facility in-house — Contractor for Federal Facility
   Other_____

2. **O&M Cost Records** See Five-Year Review Report.
   Readily available — Up to date
   Funding mechanism/agreement in place
   Original O&M cost estimate_____ Breakdown attached

   Total annual cost by year for review period if available

   From_____ To_____ _____ Breakdown attached
   Date Date Total cost
   From_____ To_____ _____ Breakdown attached
   Date Date Total cost
   From_____ To_____ _____ Breakdown attached
   Date Date Total cost
   From_____ To_____ _____ Breakdown attached
   Date Date Total cost
   From_____ To_____ _____ Breakdown attached
   Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**
   Describe costs and reasons: See Five-Year Review Report.

V. ACCESS AND INSTITUTIONAL CONTROLS — Applicable — N/A

A. Fencing

1. **Fencing damaged** — Location shown on site map — Gates secured — N/A
   Remarks Fencing around Control House only in good condition.

B. Other Access Restrictions

1. **Signs and other security measures** — Location shown on site map — N/A
   Remarks_____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented — Yes — No — N/A
Site conditions imply ICs not being fully enforced — Yes — No — N/A

Type of monitoring (*e.g.*, self-reporting, drive by) inspection during O+M
Frequency Weekly
Responsible party/agency MPCA consultant
Contact Keith Knoke — Delta Project Manager — as needed — 651-697-5188
Name — Title — Date — Phone no.

Reporting is up-to-date — Yes — No — N/A
Reports are verified by the lead agency — Yes — No — N/A

Specific requirements in deed or decision documents have been met — Yes — No — N/A
Violations have been reported — Yes — No — N/A
Other problems or suggestions: Report attached
See Five-Year Review Report

2. **Adequacy** — ICs are adequate — ICs are inadequate — N/A
Remarks ICs will be adequate when implemented if buyers request title search.

D. General

1. **Vandalism/trespassing** — Location shown on site map — No vandalism evident
Remarks

2. **Land use changes on site** N/A
Remarks

3. **Land use changes off site** N/A
Remarks

VI. GENERAL SITE CONDITIONS

A. Roads — Applicable — N/A

1. **Roads damaged** — Location shown on site map — Roads adequate — N/A
Remarks Plugged MNDOT culvert causes backup to drive access during high water

VII. LANDFILL COVERS NA
VIII VERICAL BARRIER WALLS NA

IX. GROUNDWATER/SURFACE WATER REMEDIES Applicable N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines Applicable N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   Good condition All required wells properly operating Needs Maintenance N/A
   Remarks

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance
   Remarks

3. **Spare Parts and Equipment**
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks Parts are available in a reasonable amount of time.

B. Surface Water Collection Structures, ~~Pumps, and Pipelines~~ Applicable N/A

1. **Collection Structures, ~~Pumps, and Electrical~~** Site map needs update.
   Ditches Good condition, may Needs Maintenance for silting
   Remarks Additional ditching on north side was found, not a problem. Culvert appears plugged and backing up, needs follow up.

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   Good condition Needs Maintenance NA
   Remarks

3. **Spare Parts and Equipment** NA
   Readily available Good condition Requires upgrade Needs to be provided
   Remarks

C. Treatment System Applicable N/A

1. **Treatment Train** (Check components that apply)
   - Metals removal
   - Oil/water separation
   - Bioremediation
   - Air stripping
   - Carbon adsorbers
   - Filters
   - Additive (*e.g.*, chelation agent, flocculent)
   - Others Local POTW: WLSSD under MPCA NPDES permit, enforcement
   - Good condition
   - Needs Maintenance
   - Sampling ports properly marked and functional
   - Sampling/maintenance log displayed and up to date
   - Equipment properly identified
   - Quantity of groundwater treated annually See Five-Year Review Report.
   - Quantity of surface water treated annually N A
   - Remarks

2. **Electrical Enclosures and Panels** (properly rated and functional)
   - N/A
   - Good condition
   - Needs Maintenance
   - Remarks Repaired in spring 2002.

3. **Tanks, Vaults, Storage Vessels**
   - N/A
   - Good condition
   - Proper secondary containment
   - Needs Maintenance
   - Remarks

4. **Discharge Structure and Appurtenances**
   - N/A
   - Good condition
   - Needs Maintenance
   - Remarks

5. **Treatment Building(s)** - Control Building
   - N/A
   - Good condition (esp. roof and doorways)
   - Needs repair
   - Chemicals and equipment properly stored
   - Remarks

6. **Monitoring Wells** (pump and treatment remedy)
   - Properly secured/locked
   - Functioning
   - Routinely sampled
   - Good condition
   - All required wells located
   - Needs Maintenance
   - N/A
   - Remarks

D. Monitoring Data

1. Monitoring Data
   - Is routinely submitted on time
   - Is of acceptable quality

2. Monitoring data suggests:
   - Groundwater plume is effectively contained
   - Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
   Properly secured/locked Functioning Routinely sampled Good condition
   All required wells located Needs Maintenance N/A
   Remarks Natural attenuation as remedy was not selected, however it is occurring in soils resulting in reduced concentration in ground water

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, ~~attach an inspection sheet~~ describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. Alternate water supply of water main and connections is owned and maintained by the city of Hermantown.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

See Five-Year Review Report.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

See Five-Year Review Report.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

No issues or observations in cost or scope of O+M or repairs except plugged culvert

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

See Five-Year Review Report Attachment 6, Memorandum, August 26, 2002, Natural Attenuation Site Status.

Arrowhead Refinery Co. Superfund Site
Five-Year Review
Site Inspection Checklist Supplement
August 6, 2002

Inspection Team

Maureen Johnson, Project Manager, Minnesota Pollution Control Agency (MPCA)
Barb Gnabasik, Hydrogeologist, MPCA

II. Interviews

The following interviews are described in the Five-Year Review:
O&M Site Manager, Keith Knoke, Delta Environmental, Inc.
O&M Staff, Karen Thole, Delta Environmental, Inc.
Bill Wilson, property owner.

Few changes are occurring within the area of concern.

Inspection Record

We began the inspection at one of the original buildings at the site. The building is on a higher elevation than the rest of the site and has been refurbished to a HOM furniture warehouse. The only other building on the site is the fenced and locked wells pump house.

We inspected the monitoring wells and recovery well manholes, all in good condition and secure.
A MDH well drilling advisory area designation is not needed since all monitoring wells are indicating no escape of contaminants beyond the site boundary.
We observed ponding appearing to be backing up from the culvert designated on the maps. This is contrary to the design of our RA drainage plan on the site, and could affect the ground water flow and pumping required and control of contaminant migration.

Photos

Photos were taken during the inspection and recently which are included with this supplement.

Map, with notes

See the attached map with locations of recovery wells manholes, monitoring wells, EPA diversion ditch.

Overall Observations

A. Implementation of the Remedy, Issues and observations relating to whether the remedy is effective and functioning as designed:

See the Five-Year Review for implementation of the remedy. Concentrations in the ground water have continued to decrease at a rate faster than predicted. This indicates that the removal of the source materials of the plume to the levels required in the ROD was an effective part of the remedy.

B. Adequacy of O&M

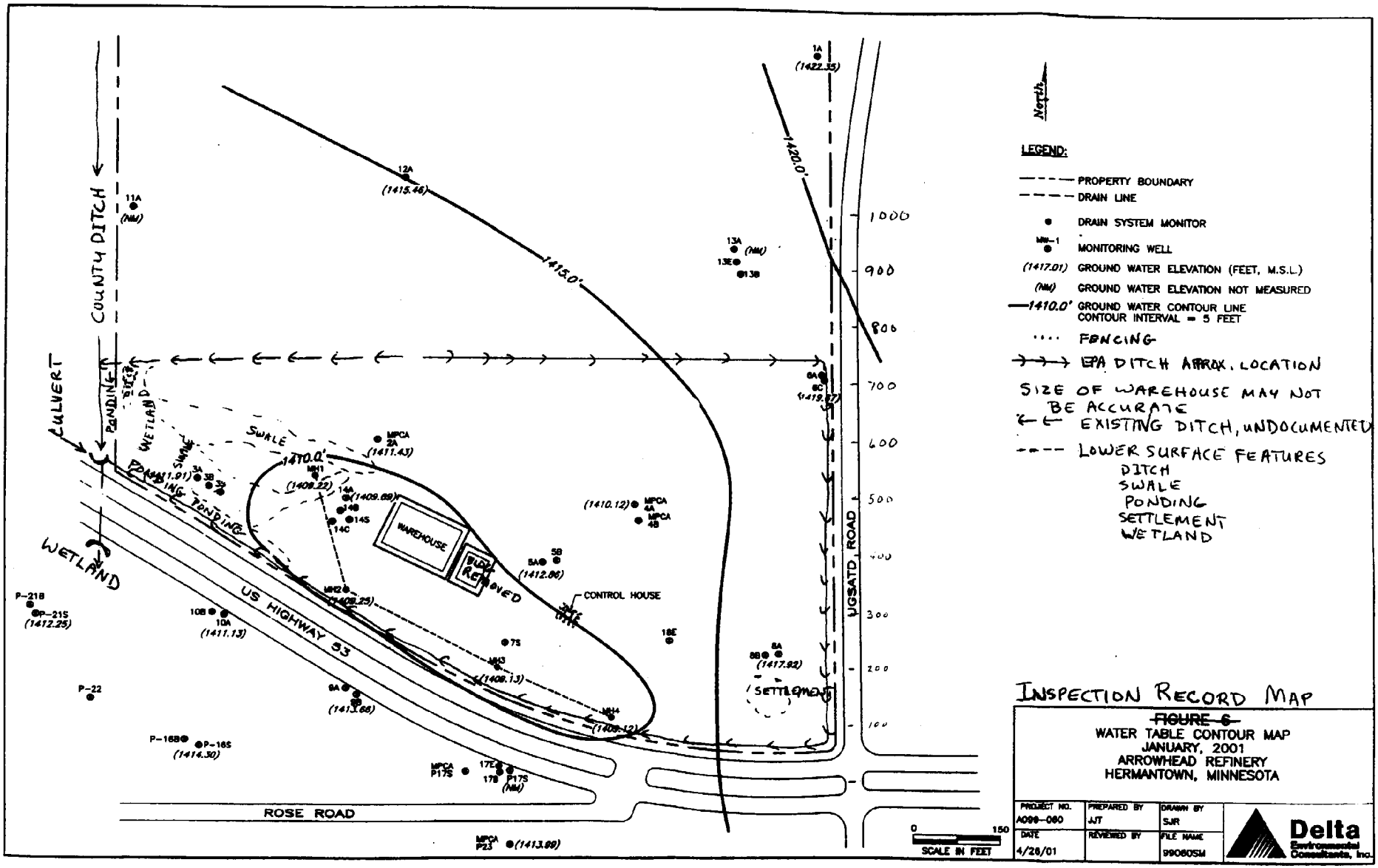
The O&M is being conducted as planned, adjustments have been made as described in annual reports, and no issues were identified to be addressed in the future. The current and long-term protectiveness of the remedy are supported by the O&M which prevents migration of contamination from the site and continues to drastically improve the quality of the discharge.

C. Early Indicators of Potential Remedy Problems

Drainage issues.

D. Opportunities for Optimization

None identified.



INSPECTION RECORD MAP

~~FIGURE 6~~

WATER TABLE CONTOUR MAP
JANUARY, 2001
ARROWHEAD REFINERY
HERMANTOWN, MINNESOTA

PROJECT NO.	PREPARED BY	DRAWN BY
A098-080	JJT	SJR
DATE	REVIEWED BY	FILE NAME
4/26/01		99080SM

Delta Environmental Consultants, Inc.

ATTACHMENT 3 (CONTINUED)
PHOTOGRAPHS

Photographs

Mvc-694f

County ditch/ power line to the west

Mvc-695f

County Ditch and wetland at culvert under Highway 53

Mvc-696f

Foreground is typical site condition with clover and vegetation found in upland infertile soils.

Mvc-697f

Looking north, the light colored pad for the new warehouse development north of the site can be seen in the center of the picture. A residence is also seen on the east side of LaVaque Bypass. Vegetation defining the north edge of the Coast Guard ditch can also be seen just below the pad.

Mvc-732f

732 - East side of pump out control building fence, looking north.

Mvc-733f

733 - Looking west along Hwy. 53. Manhole 1 in foreground. Manhole 2 in background. EPA ditch to right of Hwy. 53

Mvc-734f

734 - Pump house control building - looking northwestward.

Mvc-735f

735 - East side of Hom Furniture Warehouse, looking north.

Mvc-736f

736 - West side of Hom Furniture Warehouse. Ditch that discharges to the EPA ditch along Hwy. 53 just beyond Como Propane tank.

Mvc-737f

737 - Discharge of tributary to the EPA ditch on the south side.

Mvc-738f

738 - West side of Hom Furniture Warehouse, tributary to EPA ditch shown.

Mvc-739f

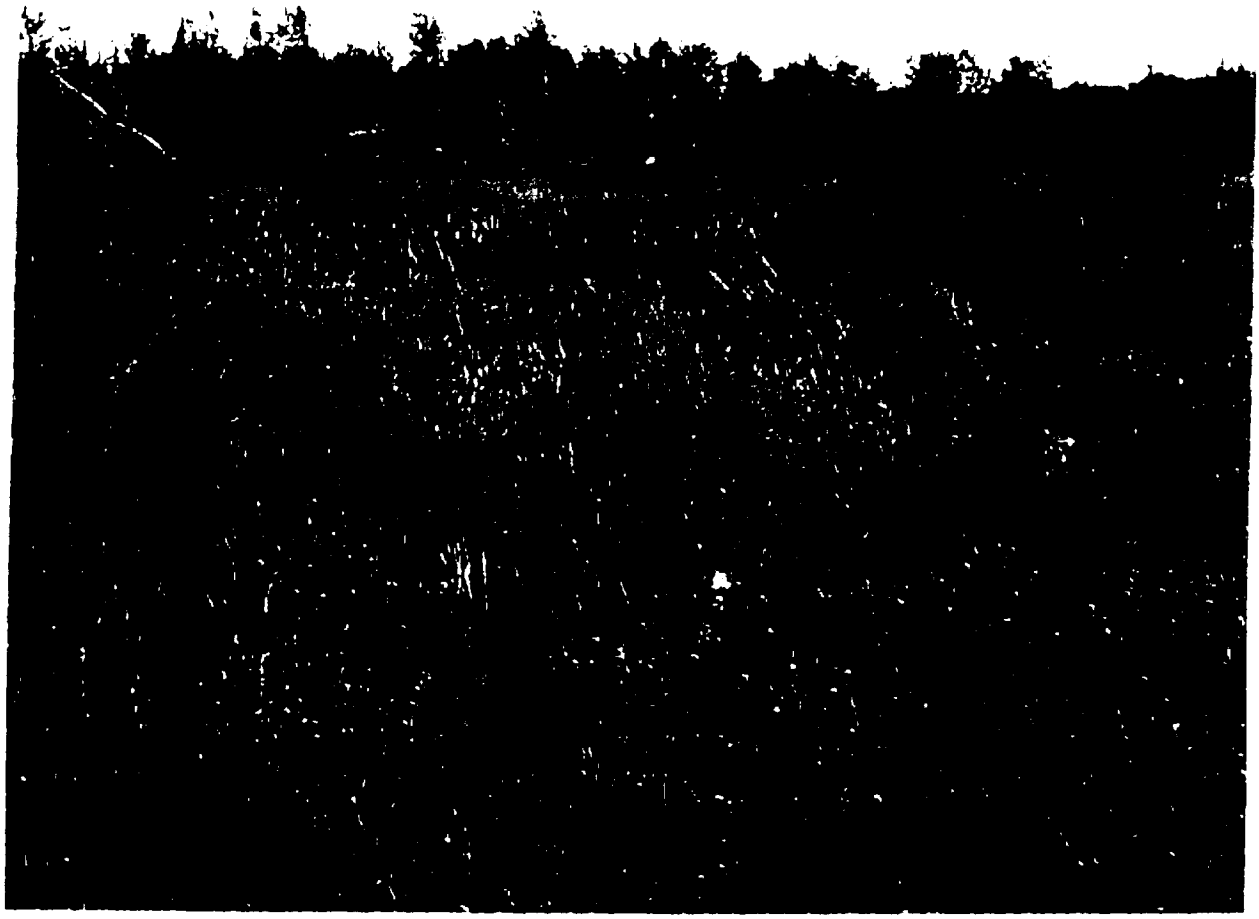
739 - Looking east along Hwy. 53.

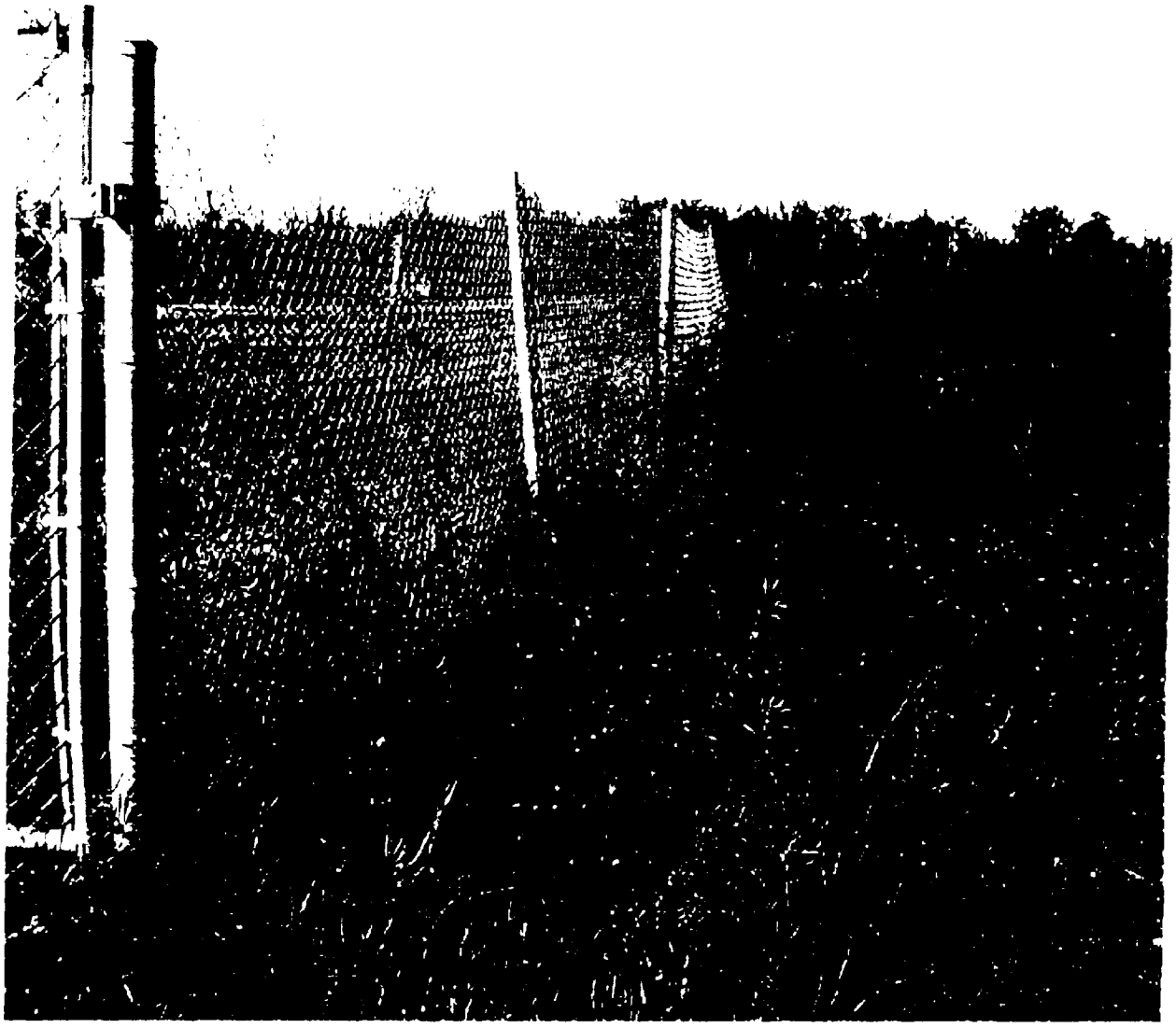
Mvc-740f

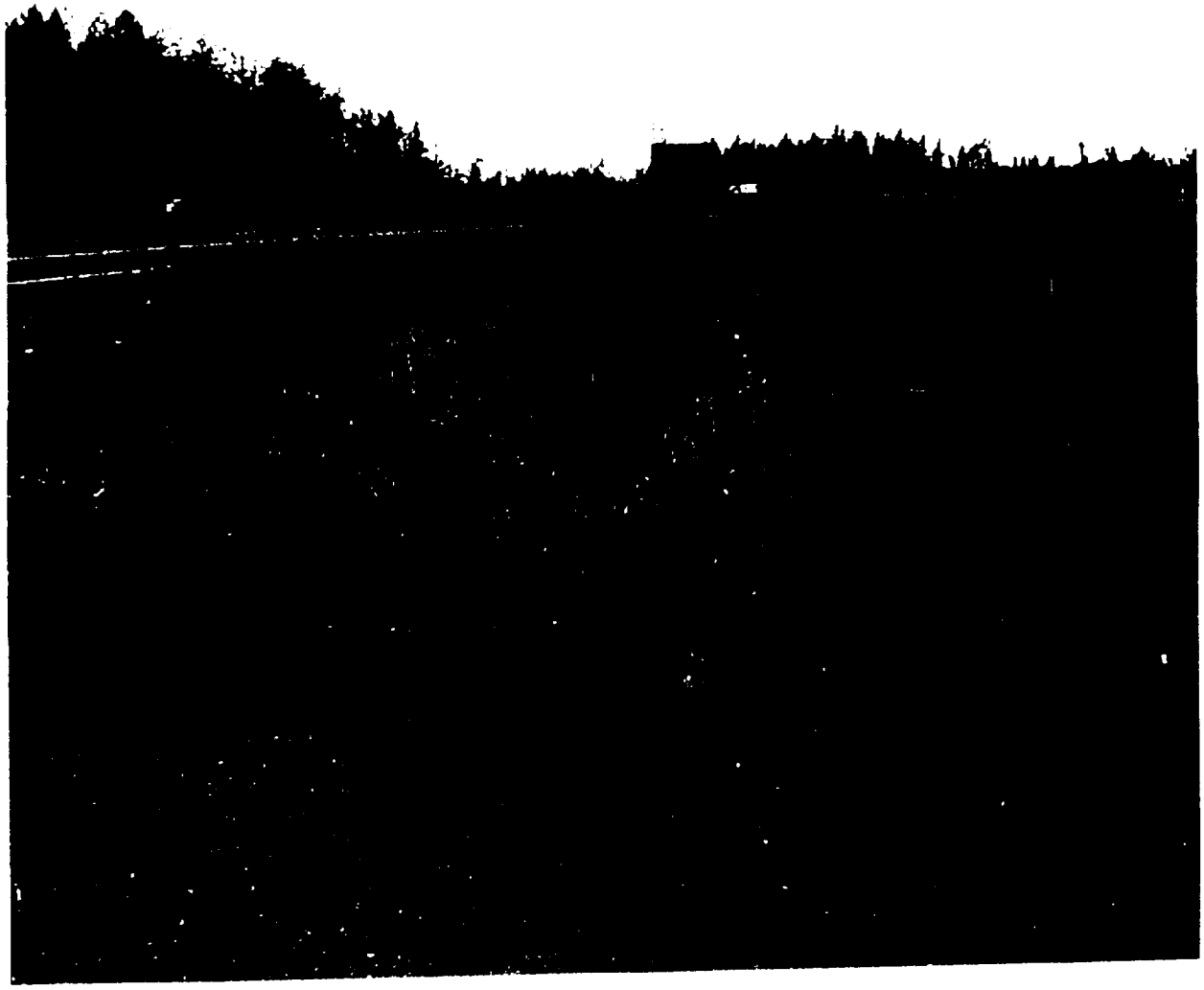
740 - Looking west, Hom Furniture Warehouse.

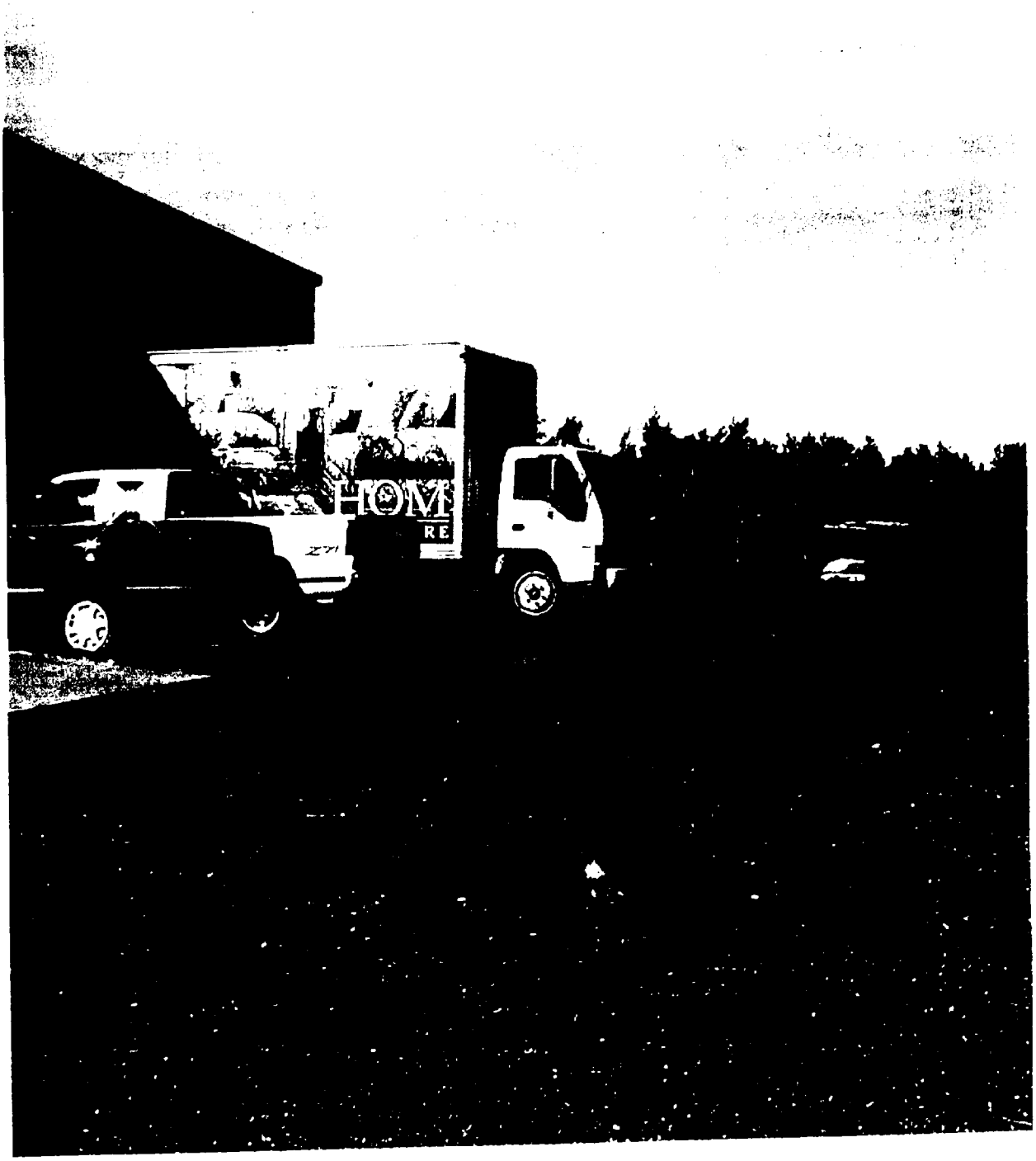
Mvc-741f

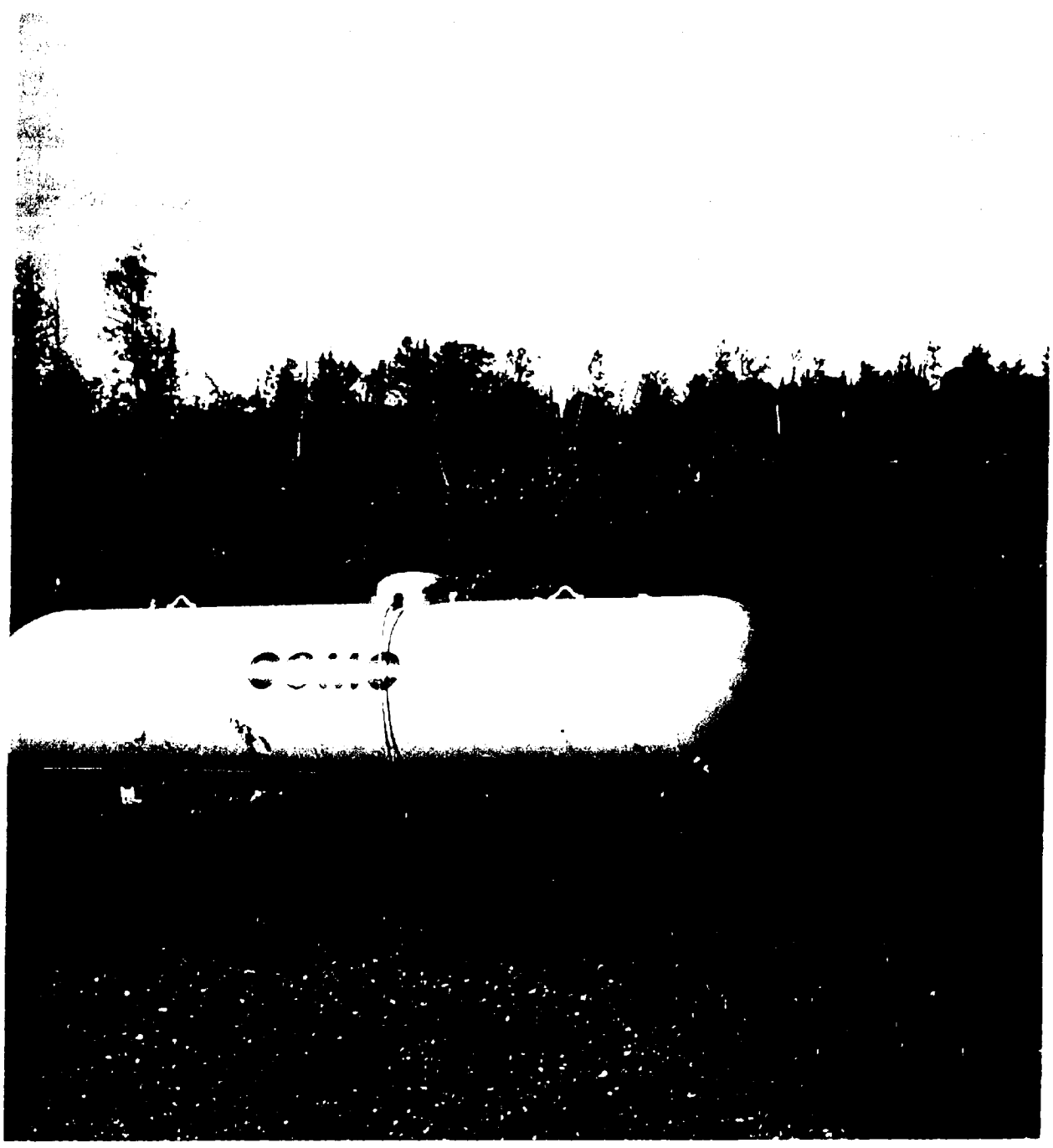
741 - Looking southeast, one of the settled areas shown by cattails in foreground.

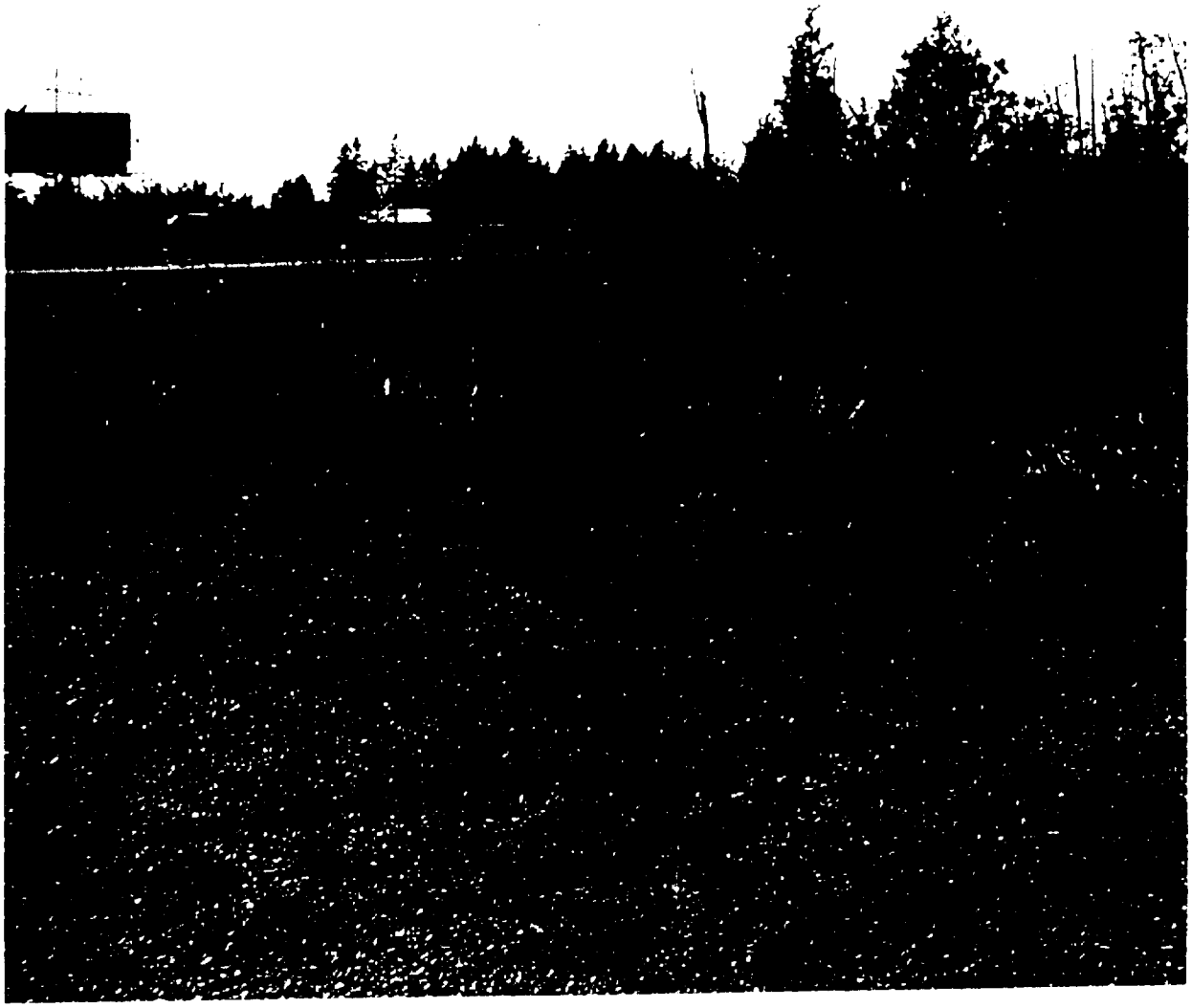


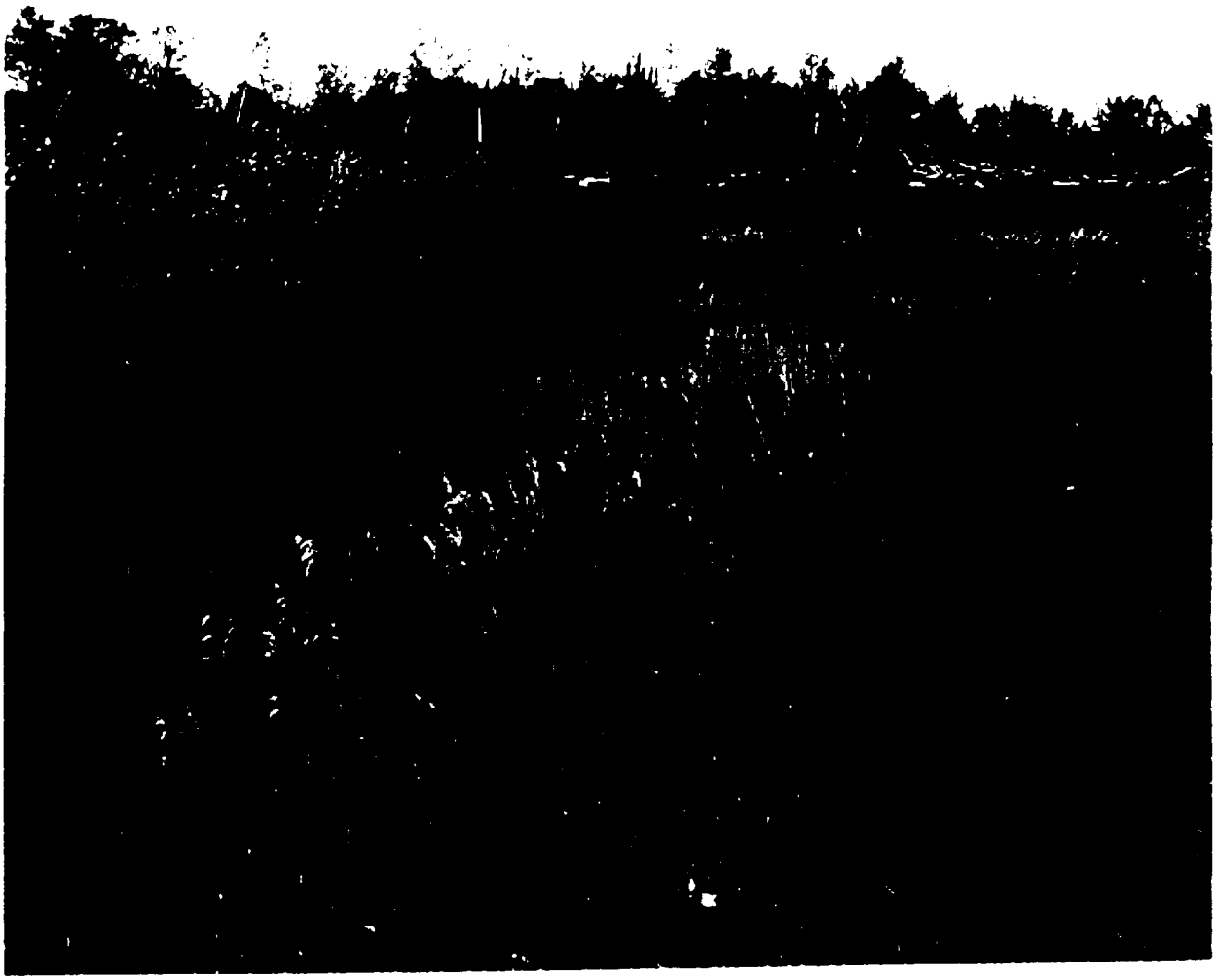




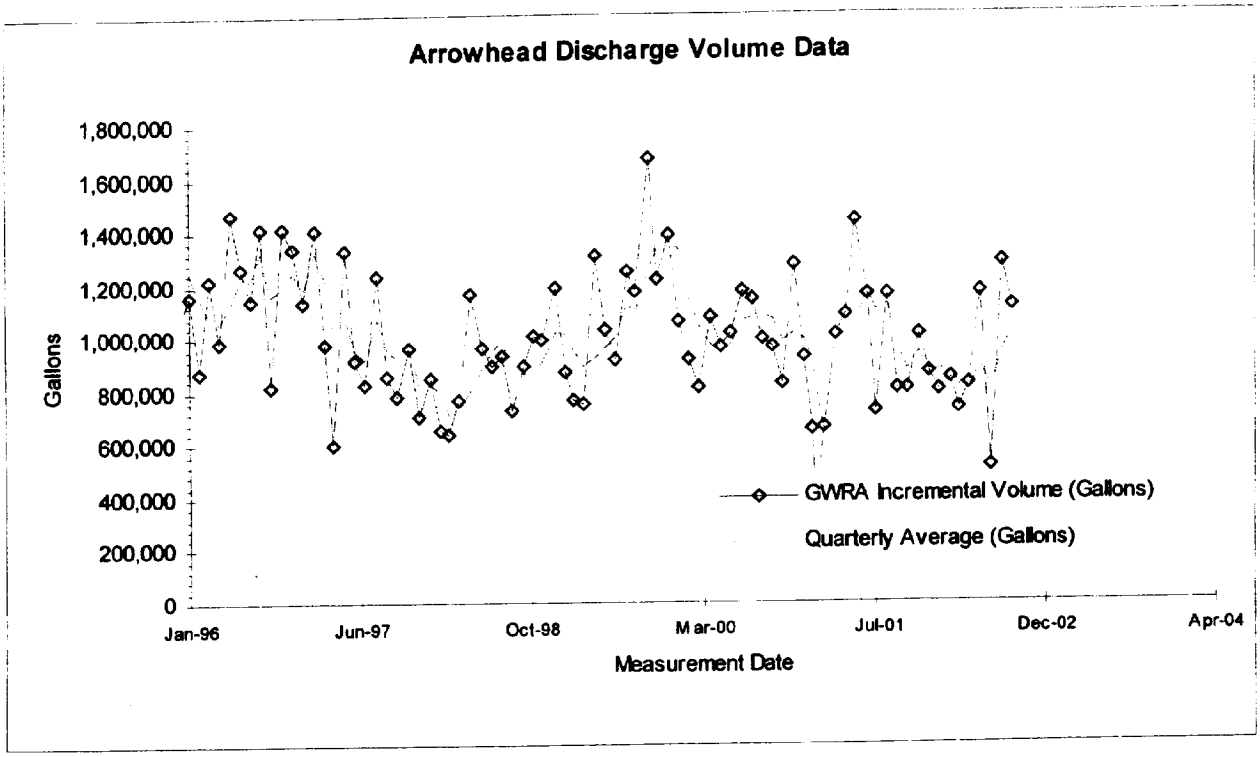

HOM
RE







ATTACHMENT 4
DISCHARGE VOLUME SUMMARY DATA



ATTACHMENT 5
GROUND WATER ELEVATIONS

Arrowhead Groundwater Elevations

7A/B/C Abandoned Prior to June-92 Sampling

[redacted]

Arrowhead Ground

7A/B/C Abandoned Prio

	Dec-84	Jun-85	Jun-86	Jun-92	Jun-93	Sep-93	Jan-94	Apr-94	May-95	Jul-95	Nov-95
1A	1422.22	1422.28	1422.13	1422.30	1421.57	1422.30	1422.21	1422.78	1422.55	1422.18	1422.50
[redacted]	1415.23	1415.97	1415.48	1415.49	1415.77	1415.58	1413.91	1415.87	1415.79	1415.50	1415.66
	1416.07	1416.11	1415.83	1415.97	1411.55	1412.09	1411.00	1413.00	1412.21	1411.97	1412.18
	1415.82	1416.10	1415.80	1415.95	1409.83	1410.61	1409.82	1411.67	1410.74	1410.54	1410.72
				1415.92	1409.75	1410.59	1409.79	1411.87	1410.67	1410.44	1410.63
	1415.54	1416.11		1415.39	1415.81	1415.68	1413.70	1415.97	1415.98	1414.62	Stuck Cap
MPCA-2A											
3A	1414.56	1414.96	1414.44	1414.64	1408.22	1409.71	1409.55	1411.12	1409.93	1409.67	1409.78
3B	1414.91	1415.10	1414.68	1414.82	1405.76	1408.33	1408.23	1409.87	1408.64	1408.42	1408.58
3S				1413.97	1413.41	1413.57	1408.17	1414.15	1413.81	1412.37	1413.83
[redacted]	1417.57	1417.64		Product	Product	Product	Product	Product	1409.64	Product	[redacted]
	1416.62	1421.50		1415.83	1407.63	1409.32	1408.56	1411.23	Product	1409.08	
	1416.92	1417.37	1417.26	1417.44	1406.80	1407.56	[redacted]	1408.40	1406.57	[redacted]	
				1417.83	1402.43	1405.46	1405.24	1407.15	1405.50	1405.43	1405.40
	1416.97	1417.43	1417.52	1417.72	1406.65	1408.50	1407.81	1409.95	1408.27	1408.26	1408.33
				1417.73	1407.14	1408.86	1408.09	1410.32	1408.60	1408.58	1408.69
		1417.54		1417.11	1417.16	1416.10	Product	1417.29	Product	Product	Stuck Cap
				1417.79	1403.40	1405.57	1405.26	1407.10	1405.36	1405.34	1405.28
				1417.42	1410.06	1408.89	[redacted]		1408.19	[redacted]	
MPCA-4A											
MPCA-4B											
MPCA-5A											
MPCA-5B											
6A	1420.21	1421.25	1419.93	1420.31	1420.62	1419.07	1418.93	1420.73	1419.80	1418.82	1419.73
6C	1420.86	1420.89	1420.92	1421.39	1420.20	1419.63	1419.06	1420.46	1419.93	1419.37	1419.94
[redacted]	1414.77	1414.83	1414.88								
		1415.93	1416.17								
		1415.93	1416.28								
8A	1418.81	1419.23	1418.34	1418.33	1420.17	1417.68	1417.17	1419.27	1418.39	1417.53	1418.13
8B				1419.40	1415.82	1415.37	1413.99	1416.02	1415.33	1415.10	1415.34
9A		1417.46	1417.71	1417.95	1416.24	1415.03	1413.20	1414.48	1414.14	1414.31	1414.63
9B		1417.34	1417.71	1417.89	1415.95	1414.88	1413.06	1413.97	1413.90	1414.10	1414.35
10A		1413.19	1411.67	1412.76	1411.41	1410.89	1409.77	1412.23	1411.49	1410.38	1411.02
10B		1413.58	1412.81	1413.37	1410.55	1410.61	1409.65	1412.02	1411.20	1410.19	1410.80
11A	1415.29	1414.87		1415.20	1414.44	1414.35	[redacted]	1414.04	1414.80	1414.38	[redacted]
12A	1416.18	1416.74	1416.35	1416.53	1415.38	1415.07	1414.76	1415.61	1415.27	1415.01	1415.19
13A	1418.59	1418.58	1418.61	1417.80	1418.48	1418.20	[redacted]	1417.96	1417.60	1417.60	1418.38
13B				1419.21	1418.33	1418.13		1418.54	1418.44	1417.97	1418.27
13E				1419.27	1417.39	1418.20		1418.36	1418.60	1418.07	1418.42
14A	1415.33	1415.67	1415.39	1415.54	1407.31	1407.65	1407.01	1409.16	1407.50	1407.42	1407.55
14B	1415.46	1415.79	1415.44	1415.59	1406.64	1407.92	1407.29	1409.88	1407.94	1407.76	1407.96
14C		1415.87	1415.39	1415.61	1405.44	1407.97	1407.62	1409.30	1408.03	1407.90	1408.02
14S				1414.87	1411.08	[redacted]		1411.96	1409.36	[redacted]	1410.36
[redacted]		1416.65	1415.93	1417.98	1410.74	1410.47	1407.65	1411.83	1410.43	1410.66	1410.50
		1416.76	1416.88	1417.68	1405.15	1407.46	1406.95	1409.31	1407.54	1407.50	Buried
16S				1417.60	1416.86	1415.69	1414.11	1414.24	1414.81	1414.77	1415.25
16B (16B)				1417.66	1416.64	1415.67	1414.09	1415.01	1414.91	1414.74	1415.15
17B				1418.47	1412.74	1413.38	1411.73	1412.38	1412.09	1412.47	1412.72
17E				1418.26	1412.52	1413.20	1411.59	1412.31	1411.94	1412.30	1412.58
P17S				1420.98	1415.13	1414.89	1412.78	1412.97	1413.01	1413.65	1416.40
MPCA17				1415.82	1416.76	[redacted]					
18E				1419.03	1409.42	1410.94	1410.24	1410.76	1410.55	1410.49	1410.93
P21B				1411.72	1412.12	1411.87	1411.83	1412.13	1411.91	1411.77	1411.76
P21S				1412.11	1412.53	1412.34	1412.11	1412.46	1412.44	1412.17	1412.28
P22				1412.20	1413.69	1412.47	1412.15	1412.68	1412.45	1412.19	1412.34
MPCA23				1418.02	1416.76	1416.45	1414.91	1414.65	1414.94	1415.27	1415.67
MH1						1404.82	1405.14	1405.87	1405.09	1403.96	1404.26
MH2						1404.82	1405.05	1405.94	1405.09	1404.49	1404.28
MH3						1404.85	1405.14	1405.77	1405.14	1404.49	1404.26
MH4						1404.84	1405.16	1405.84	1405.16	1404.55	1404.33

dwater Elevations

r to June-92 Sampling

[redacted]

May-96	Jun-97	Nov-97	May-98	Oct-98	Apr-99	Oct-99	Jan-00	Apr-00	Jul-00	Oct-00	Jan-01
1422.65	1422.70	1422.25		1417.53	1422.80	1422.54			ot reported	1422.04	1422.35
1416.06	[redacted]										
1412.26											
1410.83											
1410.74											
1420.90											
	1412.08	1411.77		1403.63	1412.17	1411.74	1410.06	ouldn't find	1411.12	1411.26	1411.43
1409.97	1412.31	1410.88		1403.61	1414.87	1407.35	1409.87	1411.05	ot reported	1410.76	1411.91
1408.64	1411.72	1410.17		1405.70	1410.44	1410.08	1408.92	1409.90	ot reported	1409.86	1410.85
1413.94	1414.39	1413.98		1409.47	1411.29	1414.77			ot reported	1412.42	OT MEAS
[redacted]											
1405.41											
1408.25											
1408.62											
1422.30											
1405.40											
	1410.61	1409.16		1397.10	1411.42	1412.33	1409.72	1410.07	1409.96	1409.93	1410.12
	1411.10	1409.22		1395.96	1409.65	1409.41	1408.74	1409.22	1408.91	1409.57	1410.10
	1412.36	1408.37		1400.71	1407.64	1414.90	1409.88	1412.85	1413.47	1412.98	1412.86
	1410.34	1407.16		1394.13	1416.31	1407.26	1407.05	1412.86	1407.20	1408.36	1409.27
1419.92	1420.84	1419.40		1412.02	1421.22	1420.12	1419.67	1420.39	1419.14	1419.26	1419.67
1420.29	1420.85	1419.75		1412.29	1420.99	1420.70	1419.80	1420.34	1419.73	1419.72	1418.36
[redacted]											
1418.74	1419.40	1417.99		1411.06	1420.07	1418.91	1418.71	1419.08	1417.72	1417.90	1417.92
1415.75	1417.18	1415.60		1406.96	1416.80	1416.73	1415.77	1416.15	1415.78	1415.64	1415.26
1414.78	1416.06	1414.61		1407.71	1415.00	1416.47	1413.73	1415.04	1414.48	1414.08	1413.66
1414.56	1415.80	1413.86		1405.94	1414.60	1416.03	1413.63	1414.40	1413.87	1413.49	1413.00
1411.60	1412.58	1411.65		1407.04	1412.35	1411.99	1409.61	1411.87	1410.86	1411.15	1411.13
1411.31	1412.66	1411.47		1406.79	1412.61	1411.96	1409.62	1411.87	1411.01	1411.23	1411.14
[redacted]	1415.05	1414.35		1411.24	Obstructed	1414.88	[redacted]		ot reported	1413.66	OT MEAS
1415.35	1415.65	1414.72		1408.75	1415.87	1415.74	1414.96	1415.57	1414.76	1414.84	1415.46
1418.67	1418.61	1417.80		1414.66	1418.31	1418.41	[redacted]	1416.62	1417.29	1417.58	OT MEAS
1418.57	1418.52	1417.95		1414.91	1418.45	1418.47	[redacted]		1417.34	1417.56	OT MEAS
1418.73	1418.67	1417.97		1415.38	1418.87	1418.64	[redacted]		1417.68	1417.84	OT MEAS
1407.62	1410.72	1408.97		1400.69	1409.40		1408.44	1408.86	1408.77	1409.00	1409.69
1407.88	1410.90	1409.15		1400.81	1409.79	1409.33	1408.67	1409.22	1408.99	1409.30	1410.05
1407.98	1411.18	1409.42		1402.20	1409.52	1409.21	1408.19	1409.12	1408.74	1409.31	1410.02
1410.90	1414.06	1409.87		1407.00	1415.35	1413.65	[redacted]	1413.73	1410.10	1409.32	OT MEAS
[redacted]											
1415.54	1416.64	1414.70		1406.27	1415.70	1417.01	1414.99	1415.73	ot reported	1414.54	1414.30
1415.46	1416.50	1414.69		1406.02	1415.50	1416.97	1415.00	1415.65	ot reported	1414.60	1414.31
1412.83	1414.97	1413.70		1401.17	1413.45	1415.18	1413.68	1413.60	1413.60	1413.43	1413.22
1412.67	1414.87	1413.70		1401.67	1412.99	1415.02	1413.53	1413.49	1413.48	1413.30	1413.15
1416.54	1415.72	1414.46		1402.90	1416.62	1415.86	[redacted]	1417.10	1417.12	1416.81	OT MEAS
[redacted]						1416.44	1414.66	1412.38	ot reporte	[redacted]	
1410.99	1412.92	1408.80		1399.34	1412.47	1413.02	1412.14	1412.58	1412.45	1412.31	1412.02
1411.92	1412.26	1411.97		1407.56	1412.20	1412.13	1410.46	1412.03	ot reported	1411.62	1411.76
1412.51	1412.71	1412.30		1408.17	1412.62	1412.73	1410.75	1412.47	ot reported	1412.16	1412.25
1412.61	1413.72	1412.79		1409.67	1412.76	1412.72	[redacted]		1412.17	1412.19	1412.10
1415.70	1416.46			1414.39	1414.29	1416.67	ot collected	1414.86	ot reported	1414.33	1413.99
	1410.24	1407.95		1397.63	1406.97	1406.57	1406.24	1407.47	1407.02	1408.12	1409.22
	1410.24	1408.01		1397.18	1406.61	1406.57	1406.46	1407.46	1406.89	1408.09	1409.25
	1410.23	1407.99		1395.87	1406.57	1406.54	1406.24	1407.42	1406.87	1408.11	1409.13
	1409.72	1407.97		1395.43	1406.62	1406.58	1406.32	1407.42	1406.77	1408.10	1409.12

[redacted]

Apr-01	Jul-01	(MPCA) Jul-01	Sep-01	T-O-C
1420.16	1422.12		1422.05	1427.17
[redacted]				1420.66
				1420.95
				1420.43
				1419.70
				1420.90
1411.18	1410.95		1410.48	1419.93
1411.72	1410.48		1410.44	1418.88
1410.18	1409.49		1409.67	1418.29
FROZEN	1412.11		1411.32	1418.53
[redacted]				1424.22
				1423.78
				1421.05
				1420.69
				1421.12
				1420.41
				1422.30
				1420.85
				1420.45
1409.59	1410.27	1410.19	1409.68	1423.42
1409.01	1409.74	1409.92	1409.44	1423.43
1411.27	1413.25	1413.59	1411.94	1422.10
1407.80	1407.69	1408.67	1408.45	1422.11
1419.90	1419.17		1419.07	1427.72
1420.05	1419.87		1419.58	1427.81
[redacted]				1422.50
				1421.73
				1421.74
1418.32	1417.80		1417.62	1426.12
1415.38	1416.17		1415.58	1424.71
1413.83	1414.82		1414.19	1421.15
1415.06	1414.09		1413.45	1421.87
1412.07	1410.92		1407.55 (erro	1416.60
1412.03	1410.99		1410.70	1416.71
FROZEN	1412.73		1410.63	1417.91
1415.67	1414.66		1414.51	1421.42
FROZEN	1417.47		1417.86	1421.51
FROZEN	1417.43		1417.43	1421.33
FROZEN	1417.86		1417.85	1421.05
1408.91	1408.94	1409.01	1408.83	1417.91
1409.22	1409.24	1409.40	1409.09	1418.34
1409.33	1408.88	1408.95	1409.07	1417.41
FROZEN	DRY		1409.25	1417.76
[redacted]				1422.80
				1423.21
1414.56	1415.31		1414.65	1423.05
1414.45	1415.35		1414.71	1423.22
1412.64	1414.19		1414.55	1425.25
1412.55	1414.07		1413.40	1424.66
1416.12	1417.67		1416.92	1427.62
[redacted]				1425.02
BURIED	1412.98		1412.26	1421.58
FROZEN	1411.35		1411.31	1416.24
FROZEN	1411.97		1411.88	1416.52
FROZEN	1411.95		1411.85	1415.63
1414.39	1415.95		1415.35	1432.27
1407.55	1406.74		1408.22	1418.55
1407.04	1406.78		1408.25	1419.06
1406.35	1406.69		1408.18	1420.39
1406.41	1407.21		1408.17	1420.81

ATTACHMENT 6
AUGUST 26, 2002 MEMORANDUM REGARDING THE STATUS OF GROUND WATER CLEANUP AT THE ARROWHEAD REFINERY SITE

ATTACHMENT 6

DEPARTMENT: POLLUTION CONTROL AGENCY

SF-00006-05 (4/66)

STATE OF MINNESOTA

Office Memorandum

DATE: August 26, 2002

TO: Maureen Johnson
Project Manager

FROM: Barbara J. Gnabasik
Hydrogeologist

PHONE: (218) 529-6266

cc: Mark Ferrey

SUBJECT: Arrowhead Refinery Natural Attenuation Site Status and Possible Ways to Speed Up the Ground Water Cleanup

The Arrowhead Refinery Site (Site) is located in Hermantown in St. Louis County, about eight miles northwest of the city of Duluth. The Refinery reclaimed waste oil from 1945 to 1977. During this time, Minnesota Pollution Control Agency (MPCA) records indicate that a highly acidic metal-laden sludge was disposed in an uncontained two-acre lagoon on the property. The site was added to the National Priorities List in October 1983 with a score of 43.75. The Coast Guard constructed a ditch around most of the property to divert surface water from running onto the Site. Municipal water was extended to private homes downgradient of the Site and a French Drain was installed to capture and restore the contaminated ground water beneath the Site and to prevent off-site migration of the contaminant plume. Contaminated ground water that is pumped from the French Drain is discharged without the need for pre-treatment to the Western Lake Superior Sanitary District (WLSSD) Wastewater Treatment Facility. In 1995 and 1996, the source area and contaminated soils and sediments were excavated. For organics, a visual standard was used. For lead, the source areas were removed, and soil and sediments were cleaned up to 500 mg/kg.

At this time, the second Five Year Review of the Remedy, as triggered by the first Five Year Review, is due. Ground water at the Site is cleaning up at a rate faster than expected. Only two sampling locations have exceeded the Maximum Contaminant Level (MCL) of 2.0 micrograms per liter (ug/L) for vinyl chloride in the past year. In addition, the lead at the tap standard of 15 ug/L was exceeded in the discharge only and only for two out of the last ten sampling events. Finally, the gasoline range organics (GRO) and diesel range organics (DRO) Health Based Value (HBV) of 200 ug/L, that was established by the Minnesota Department of Health (MDH), is occasionally exceeded at one well. In this memorandum, MPCA staff evaluates the nature of the remaining contamination and the natural attenuation of the organic contaminants at the site so that all cleanup standards can be achieved cost effectively.

Remedial Action Objectives and Ground Water Cleanup Numbers in the Amended Record of Decision

According to Page 2 of the February 9, 1994 Amended Record of Decision (AROD) for the Arrowhead Refinery Site, the 1986 Record of Decision (ROD) ground water component was the extraction and treatment system to be operated until 10^{-6} lifetime cancer risk levels are achieved (estimated at 25 – 50 years). Page 32 of the AROD states that

> "One of the goals of the groundwater component of this remedial action is to restore the surficial aquifer to a quality consistent with its beneficial use which is for domestic use. Groundwater cleanup criteria to meet the remediation goals have been determined by examination of the Safe Drinking Water Act MCLs and the use of a human health risk assessment to determine contaminant concentrations that are protective of human health. EPA and MPCA have determined that once the aquifer meets MCLs, it will be safe for human consumption. MCLs are listed in Table 4-4. Also listed are Minnesota Department of Health Risk Limits (HRLs) and Recommended Allowable Limits (RALs) (HRLs supersede RALs where both exist for a single contaminant)."

Table 4-4 (page 22) recognizes the MCLs, HRLs, and RALs as of February 9, 1994, and we can observe that some contaminants have HRLs (protective of ground water) or RALs (protective of private water supplies) but not MCLs, and some contaminants exceed HRLs or RALs. In the AROD, these MDH HRL and RAL numbers are based on 10^{-5} risk levels. They are provided for additional information about cleanup goal derivations and comparison to cleanup results, but HRLs or RALs are not cleanup goals listed in the 1994 AROD for this site. The United States Environmental Protection Agency (USEPA) response to a comment in the AROD Responsiveness Summary specifically states:

> "The ground water aquifer will be restored to MCLs rather than to a 10^{-6} health based levels in accordance with EPA policy and guidance."

MCLs are federally promulgated drinking water standards for public water supplies based not only on risk, but also laboratories' detection limits, cost, feasibility of treatment technology, and other factors; so MCLs were considered reasonable cleanup levels for this site. Applicable, relevant and appropriate requirements are determined by the circumstances. In this case, the State Minn. Rules Chapter 7060 classification of all underground waters for use as potable water supplies is the Applicable or Relevant and Appropriate Requirement (ARAR), making MCLs the circumstantial ARARs.

The MCL for vinyl chloride of 2 micrograms per liter (ug/L) represents a 10^{-4} risk level and was established as the ground water cleanup level in the AROD dated February 1994. The MCL of 2.0 ug/L was chosen as the vinyl chloride cleanup level as vinyl chloride could be detected to 1 ug/L in 1994. The laboratory quantification limit could not be lowered to the MDH RAL of 0.1 ug/L in 1994. The MDH RAL of 0.1 ug/L was set at the 10^{-5} risk level.

The present HRL for vinyl chloride is 0.2 ug/L and was adopted in Minnesota Rules 4717.7100 to 4717.7800 in December 1994. The intent of the vinyl chloride HRL of 0.2 ug/L is to be protective of human health using a 10^{-5} risk level. Since that time, typical vinyl chloride detection limits have been as low as 0.2 ug/L.

For the Five Year Review and this memorandum, the MCL of 2.0 ug/L remains the vinyl chloride cleanup number. It falls within the 10^{-4} to 10^{-6} risk range, as described in Exhibit G-3 on Page G-6 of the USEPA's "Comprehensive Five-Year Review Guidance".

The lead ground water cleanup number has remained 15 ug/L at the tap, as written in Table 4-4 of the AROD. The GRO and DRO ground water cleanup number of 200 ug/L is a newer MDH HBV, established in 2002.

Remaining Ground Water Cleanup Number Exceedances

All cleanup numbers for ground water were not exceeded for the past year except for the following locations on-site:

- Discharge – Vinyl chloride consistently exceeding the MCL of 2.0 ug/L. In addition, sporadic elevated lead concentrations (2 out of 10 sampling events) exceeded the USEPA 15 ug/L "at the tap" number for lead;
- MW-14A – Vinyl chloride hovering just above the MCL of 2 ug/L for three out of six sampling events; and
- MPCA- 4A - DRO and GRO just above the MDH HBV of 200 ug/L in the last four out of six sampling events.

A summary of the analytical data for the monitoring wells and the discharge are provided in Tables 1 and 2, respectively. Figure 1 shows the locations of the monitoring wells and Figure 2 shows the ground water flow direction for October 2001.

At present, there are no receptors as the shallow ground water is contained by a French Drain System on-site and pumped out without treatment to the WLSSD sanitary sewer system. There are three residences east and sidegradient of the pump out system that were sampled in the past and found not to be at risk due to ground water contamination as the Site. Water from the three residential wells is used for drinking, cooking, and washing.

NATURAL ATTENUATION STUDY

Within the last year, MPCA staff assigned to the Site collected natural attenuation and contaminant concentration data to determine if the ground water cleanup could be accelerated. volatile organic compound (VOC) samples also were collected from each of the four individual manholes to get a better understanding of the locations of the vinyl chloride source areas in ground water. The following summarizes those findings, and consists of empirical data, natural attenuation parameter results, and a discussion of remaining carbon or energy sources.

Empirical Data of the Natural Attenuation Process

Figures 3 and 4 show the trichloroethene, cis-1,2-dichloroethene, and vinyl chloride contaminant concentrations versus time for both the discharge and well MW-14A. Contaminant concentrations at all other on-site locations where chlorinated solvents have been detected have decreased to less than detection limits or to below MCLs, HRLs and HBVs. The off-site wells have almost no detections of VOCs, DRO, GRO, or lead; no concentrations exceed MCLs, HRLs, or HBVs. Manholes 2 and 3 in the center of the Site are downgradient of the vinyl chloride source areas in ground water.

Figures 3 and 4 show a significant decrease in concentrations of vinyl chloride and cis-1,2-dichloroethene for the discharge and well MW-14A since 1992. In 1995 and 1996, the source area and the contaminated soils and sediments were excavated. Since 1996, significant reduction in levels of vinyl chloride at well MW-14A has not occurred, and the rate of reduction for vinyl chloride in the discharge has slowed. Both the discharge and well MW-14A, however, continue

to show that natural attenuation is occurring, as ethene and ethane were detected at these two locations as summarized in Table 3.

Plots of natural logarithmic (log) transformed concentrations of vinyl chloride and cis-1,2-dichloroethene for the discharge and well MW-14A are attached as Figures 5 and 6. Based on these plots for well MW-14A, natural attenuation may no longer be decreasing exponentially with time, given the variability of the data and the low correlation coefficient. Based on the plots showing the natural log-transformed vinyl chloride and cis-1,2-dichloroethene concentrations in the discharge, natural attenuation continues to occur. These plots show that concentrations of cis-1,2-dichloroethene and vinyl chloride are decreasing exponentially with time. The correlation coefficient for the regression of cis-1,2-dichloroethene concentrations as a function of time is particularly strong at 0.9243, whereas the correlation coefficient for the regression of vinyl chloride is less strong at 0.3616. One reason for the greater degree of variance is that it is difficult to sample low concentrations of vinyl chloride without having some volatilization occur during sampling and through the glass and septum prior to analysis.

The time needed to decrease to below the MCL of 2.0 ug/L for the discharge can be estimated by the equation

$$C_x = C_0 e^{-RT}$$

Where:

C_x is the concentration at time x;
C_0 is the concentration at time 0;
R is the rate of source decay, which is represented by the slope of the regression line for the log normal concentrations of the analyte and well over time; and
T is the time needed to decrease to below the MCL of 2.0 ug/L for vinyl chloride.

The equation can be rearranged to solve for Time, T as follows:

$$\frac{\text{Ln } C_x - \text{Ln } C_0}{-R} = T$$

$$\frac{\text{Ln } 2 - 4.1}{-0.0008\ (365 \text{ days})} = T$$

$$\frac{0.693 - 4.1}{-0.292} = T = \text{approx. } 11.67 \text{ years from March 1997}$$

Thus, there is approximately 6.2 years remaining, at present, before the vinyl chloride MCL of 2.0 ug/L is met at the discharge at the current rate of natural attenuation. However, the natural attenuation rate may slow if there is an inadequate food (carbon) source.

Lead concentrations in the discharge are shown in Figure 7. Lead concentrations have fluctuated since 1995 and 1996, which are the years of the source and contaminated soil and sediment removal. Since 1996, they have exceeded the lead "at the tap" action level of 15 ug/L. However, lead concentrations in the discharge are analyzed without filtering (as a total concentration) and the likely source of the lead may be digested particulates in the water sample that do not represent what is actually migrating through ground water. As stated in the Five Year Review, filtered and

unfiltered discharge samples will be collected for lead analysis quarterly for the next year in order to resolve this issue.

As shown on Figure 8, the DRO and GRO concentrations in well MPCA-4A have fluctuated at the 200 ug/L level, which is the HBV. No pattern to the detections are evident and the sum of DRO and GRO appear to be staying in the 200 ug/L range. Neither DRO or GRO have been detected in the discharge since August 2000. Only one sampling event since 1996, in January 2000, showed DRO and GRO in the discharge that exceeded the MDH HBV of 200 ug/L. So the detection of DRO and GRO in Well MPCA-4A would not extend beyond the property boundary and would not be an issue as the draft Restrictive Covenant does not allow for drilling wells or digging on the property, without MPCA staff approval.

Natural Attenuation Parameter Results

A list of the natural attenuation sampling data that was collected for the site is provided in Table 3. A summary of the work performed is provided below. The summary of work is followed by a summary of the findings, based on this work.

Summary of Natural Attenuation Data Collection Effort

1. On-site wells MW-1A, MPCA-4A, MPCA-4B, MPCA-5A, MPCA-5B, MW-14A, MW-14B, MW-14C, and the discharge were sampled for natural attenuation parameters. All of the wells listed above, except well MW-14C, are screened in the outwash layer. The "A"-designated wells are screened at the top of the water table while the "B"-designated wells are screened at the bottom of the outwash. Well MW-14C is screened within the glacial till. The geology, prior to excavation, is shown on Figures 9 and 10. Up to eight feet of fill consisting of silty sand with small- to large-sized gravel overlies one to five feet of peat. The peat overlays 10 to 25 feet of glacial outwash consisting of sandy gravel with localized deposits of silt. A glacial till is present under the outwash and has a thickness of up to eight feet. It lays 20 to 25 feet below the site and its base consists of weathered fragments of gabbro. Fractured gabbro bedrock lays below the till.
2. MPCA staff monitored temperature, pH, conductivity, resistivity, dissolved oxygen, ammonia nitrogen, ferrous iron (Fe^{+2}), manganese (Mn^{+2}), hydrogen sulfide, carbon dioxide, sulfate, alkalinity (as $CaCO_3$), turbidity, and chloride as field parameters for the on-site wells that are sampled as well as the discharge water. Also, sample replicates were collected by MPCA staff and analyzed by the MDH laboratory at a rate of at least 2:10 for the following natural attenuation parameters for the September 2001 sampling event: alkalinity; ammonia; chloride; manganese; and sulfate. Wells MW-1A, MPCA-4A, MPCA-4B, MPCA-5A, MPCA-5B, MW-14A, MW-14B, and the discharge had laboratory duplicates collected and analyzed for select natural attenuation parameters as part of the September 2001 sampling event. Only well MW-14C did not have laboratory duplicates analyzed for the September 2001 sampling event. This well does not have any detections over cleanup numbers and only a 2/10 ratio of laboratory confirmation samples versus field data was needed. MPCA staff chose wells and parameters for laboratory confirmation that had contaminant detections and all sampling locations that exceeded water quality standards and criteria were among the sampling locations chosen.

3. The discharge is collected from a pipeline of water pumped from the French drain whose bottom is at the base of the morainal till.
4. Nitrite nitrogen, nitrate and nitrite nitrogen, total organic carbon, dissolved iron, and total sulfide were analyzed at the MDH laboratory for select on-site wells.
5. With the exception of MPCA-2A, VOCs, DRO, GRO, and dissolved lead were analyzed from samples collected from the routinely sampled on-site wells as part of the April and September 2001 sampling events. For well MPCA-2A, GRO was not analyzed as part of the April 2001 sampling event. The off-site wells that are routinely sampled had water samples that were analyzed for VOCs, dissolved lead, and DRO. The discharge was sampled four times in January, April, July, and September 2001 for VOCs, DRO, GRO, and total lead.

Findings

Table 4 provides a summary of the findings of the natural attenuation study for select on-site wells and the discharge. As can be seen from the "TYPE OF ENVIRONMENT COLUMN", the discharge is strongly reducing and the MPCA staff conclude that, based on the screening results, anaerobic degradation of vinyl chloride continues to occur at the Site for the present time.

Well MPCA-4A has an adequate reducing environment, so further degradation of GRO and DRO would only occur more slowly with the GRO and DRO functioning as a carbon food source for the microbial reduction of chlorinated compounds.

Well MW-14A has an adequate to somewhat reducing environment. This matches the log normal vinyl chloride concentrations versus time plot found in Figure 4.

Remaining Carbon or Energy Sources

Based on the dissolved organic carbon information provided in Table 3, the dissolved organic carbon (DOC) numbers do not exceed 20 mg/L at any locations. The DOC range is highest at well MPCA-5B at 15 mg/L and lowest at well MW-14B at 2.8 mg/L. However, neither of these wells have any remaining detections of vinyl chloride. Well MW-14A is the well that has had vinyl chloride concentrations greater than the MCL of 2 ug/L in the past. Well MW-14A and the discharge have DOC concentrations of 9.1 mg/L and 5.2 mg/L, respectively. Also, petroleum contaminants are no longer detected in the water samples of well MW-14A or the discharge. The petroleum contaminants probably serve as an energy source to the microbial consortia responsible for the reductive dehalogenation of chlorinated aliphatics. Thus, one limiting factor controlling the rate of further degradation of vinyl chloride at the Site may be a limited carbon source. The ethene and ethane data, however, indicate that natural attenuation is occurring.

Alternatives for Completing Ground Water Cleanup at the Arrowhead Refinery Site

Whether or not there should be any supplementing of the ground water response action presently being conducted is a function of time and costs. There are three alternatives for completing the ground water cleanup at the Arrowhead Refinery Site. They are:

1. Status Quo. Continue to let natural attenuation proceed at its present rate, continue operating the pump out system, and continue sampling but at a reduced rate.

2. Faster Anaerobic Degradation Alternative. This alternative is based on achieving a faster rate of anaerobic degradation. It includes removing contaminant mass that is absorbed to the matrix soils at and below the water table. The work that would need to be performed includes:
   - Define the specific areas that are exceeding standards with a geoprobe investigation;
   - Design and implement injections of a heated nutrient such as hydrogen release compound (HRC), vegetable oil, corn syrup, polylactate ester, molasses, or similar nutrient to increase the organic carbon content and increase the rate of anaerobic degradation;
   - Continue operating the pump out system; and
   - Continue sampling, but modify the sampling plan to fit the alternative. Reduce sampling at other locations on- and off-site as described below.
3. Aerobic Degradation Alternative. This alternative is based on changing the geochemical environment to aerobic degradation. For this alternative, contaminant mass is not removed from the matrix soils below the water table. It includes:
   - Define the specific areas that are exceeding standards with a geoprobe investigation;
   - Design and implement an air sparging/soil vapor extraction (SVE) system to inject air into the areas of the subsurface that need to be aerated.
   - Continue operating the pump out system; and
   - Continue sampling but modify the sampling plan to fit the alternative. Reduce sampling frequency in other on-site and off-site areas as described below.
   - Operations and Maintenance (O&M) action to deal with massive iron and manganese fouling.

In Table 5, MPCA staff evaluates each of these alternatives below for purposes of costs, meeting the remedial action objectives and cleanup numbers in a more timely fashion and to save money.

Recommendations for Action

MPCA staff are currently recommending Alternative 1, continue monitored natural attenuation with operation of the pumpout system. With cost effectiveness in mind, Alternative 1 is preferred as cleanup may occur within the next 5 ½ years and would still be in the same price range as the next cheapest alternative.

Alternative 2 involves requesting an anaerobic degradation evaluation from a contractor and possible follow-through with implementation. Alternative 2 would need to be effective and cost effective, based on experiences of other sites. There is no guarantee that the Alternative 2 remedy would appreciably speed up the cleanup. Favorable results from a pilot test would be needed to confirm that Alternative 2 would be effective and cost-effective. Alternative 2 will require additional funding up front, and more staff time that is less available due to Superfund staff reduction and attention to priorities. The MPCA staff believes that Alternative 1 will serve the same purpose with less effort.

Alternative 3 is rejected due to greater costs including costs associated with maintenance and complications from iron and manganese fouling and the greater costs and staff effort associated with implementation and maintenance. Iron and manganese would likely need to be aerated in addition to vinyl chloride and the aquifer environment would need to be made aerobic.

Recommendations for Changes in Sampling Schedules, Locations and Analytes

With regard to Alternative 1, MPCA staff recommends that sampling be modified to one large event per year instead of two per year. Ground water samples from the wells that continue to show exceedances should be collected six months after the annual event. The parameter list should be the same as in the fiscal year 2002 (FY02) sampling and analytical plan, with one addition. Filtered and total lead should be collected at the French drain discharge for four consecutive sampling events. The purpose of this sampling to confirm that the likely source of the lead seen previously may be digested particulates in the water sample that do not represent what is actually migrating through ground water.

Natural attenuation monitoring should be discontinued except for the well stabilization readings of temperature, pH, conductivity, dissolved oxygen, and oxidation-reduction potential. Water levels and discharge samples should continue to be collected and sampled quarterly to verify containment and to comply with the requirements for discharge established by the WLSSD. Discharge volumes will continue to be collected monthly per the requirements of the agreement with the WLSSD. Four quarters of filtered and unfiltered samples will be collected from the discharge for lead analysis.

REFERENCES:

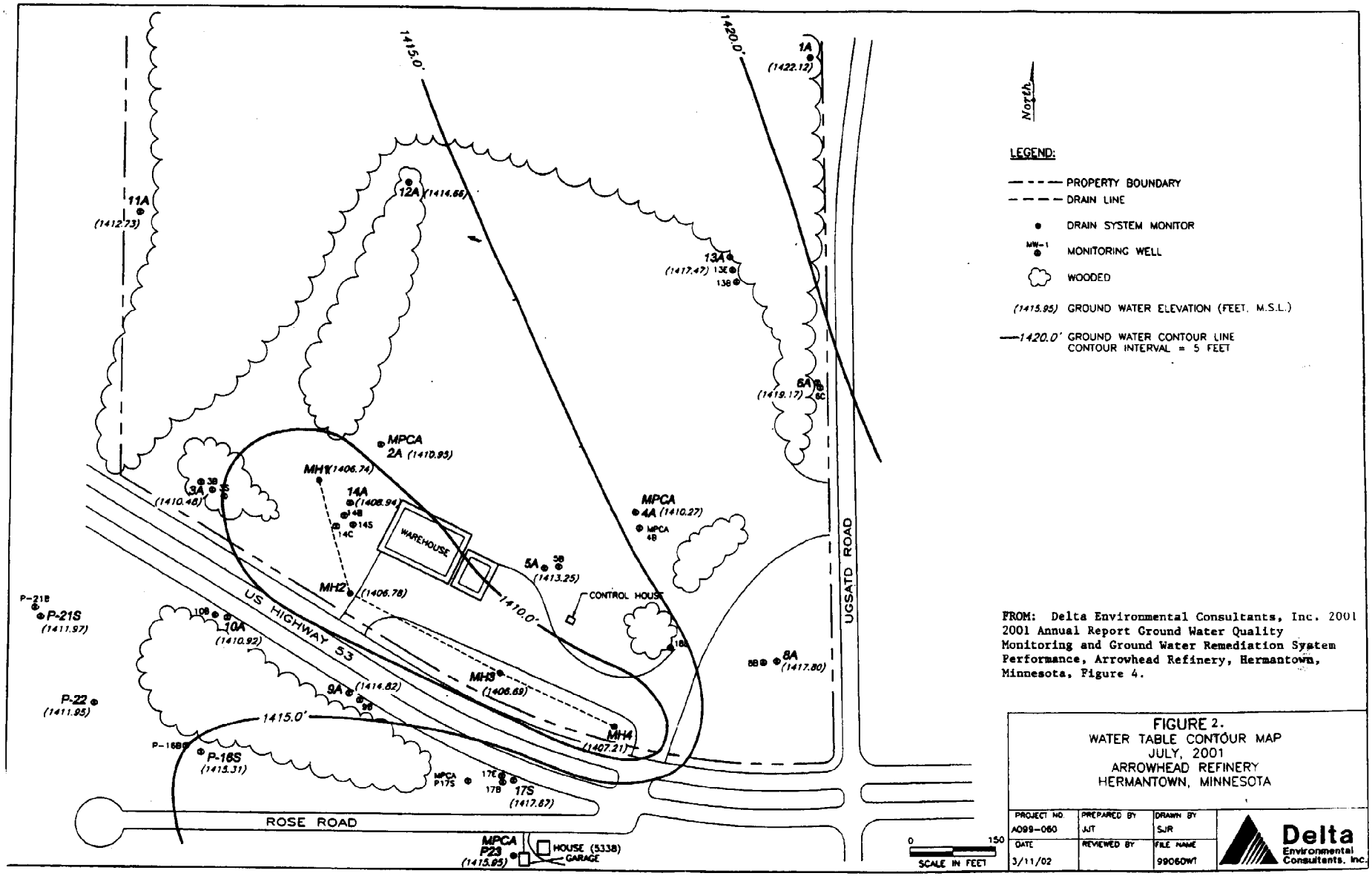
1. Minnesota Pollution Control Agency, 1999, Guidelines, Natural Attenuation of Chlorinated Solvents in Ground Water, 48p.
2. United States Environmental Protection Agency, 1994, Amended Record of Decision, Arrowhead Refinery Site.
3. Minnesota Pollution Control Agency, Arrowhead Refinery Data Files.
4. United States Environmental Protection Agency, 2001, Comprehensive Five-Year Review Guidance, Office of Emergency and Remedial Response, June, EPA 540-R-01-007, OSWER No. 9355.7-03B-P.

ACKNOWLEDGEMENTS:

The author would like to thank Mark Ferrey, MPCA's natural attenuation specialist, Maureen Johnson, MPCA project manager, and Keith Knoke of Delta Environmental Consultants, Inc. for their reviews and inputs into this document.

BG:kt

Attachments

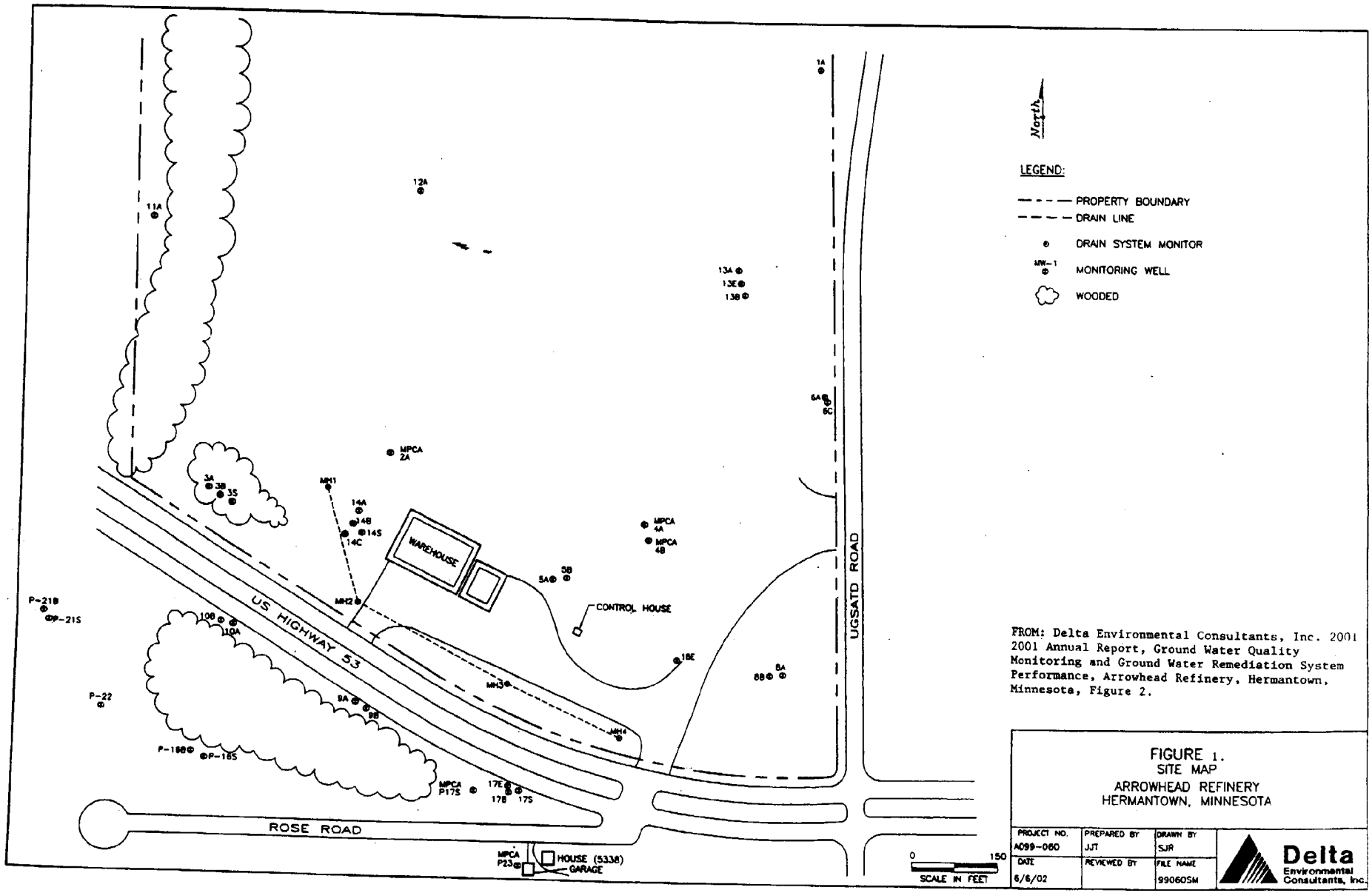


FROM: Delta Environmental Consultants, Inc. 2001 2001 Annual Report Ground Water Quality Monitoring and Ground Water Remediation System Performance, Arrowhead Refinery, Hermantown, Minnesota, Figure 4.

FIGURE 2.
WATER TABLE CONTOUR MAP
JULY, 2001
ARROWHEAD REFINERY
HERMANTOWN, MINNESOTA

PROJECT NO.	PREPARED BY	DRAWN BY
A099-060	JJT	SJR
DATE	REVIEWED BY	FILE NAME
3/11/02		99060W1

Delta Environmental Consultants, Inc.



FROM: Delta Environmental Consultants, Inc. 2001 2001 Annual Report, Ground Water Quality Monitoring and Ground Water Remediation System Performance, Arrowhead Refinery, Hermantown, Minnesota, Figure 2.

FIGURE 1.
SITE MAP
ARROWHEAD REFINERY
HERMANTOWN, MINNESOTA

PROJECT NO.	PREPARED BY	DRAWN BY
A099-060	JJT	SJR
DATE	REVIEWED BY	FILE NAME
6/6/02		99060SM

Delta Environmental Consultants, Inc.

FIGURE 3 - TCE, 1,2-DCE, AND VINYL CHLORIDE CONCENTRATIONS VERSUS TIME FOR THE DISCHARGE

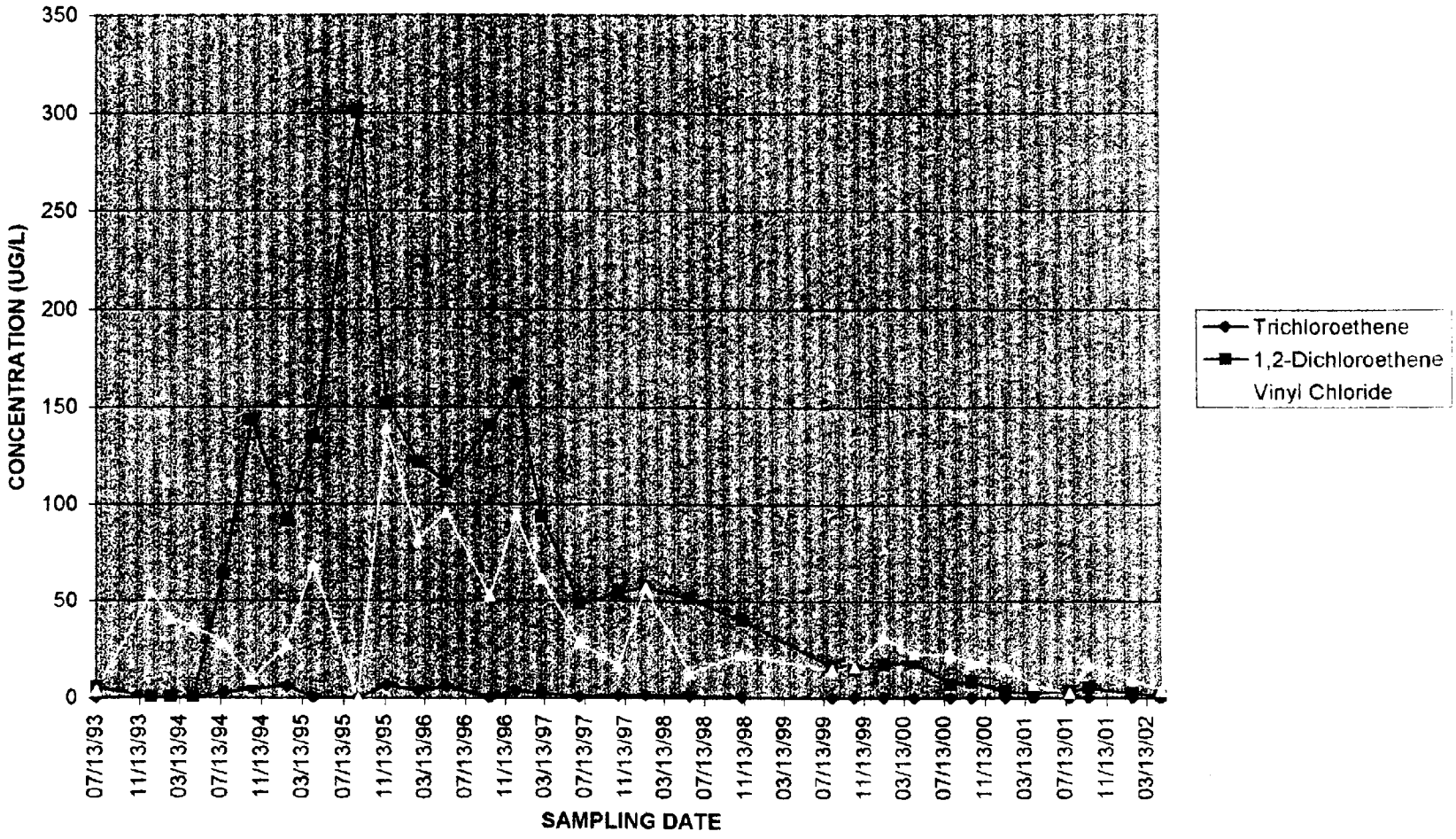


FIGURE 4 - TCE, 1,2-DCE, AND VINYL CHLORIDE CONCENTRATIONS VERSUS TIME FOR WELL MW-14A

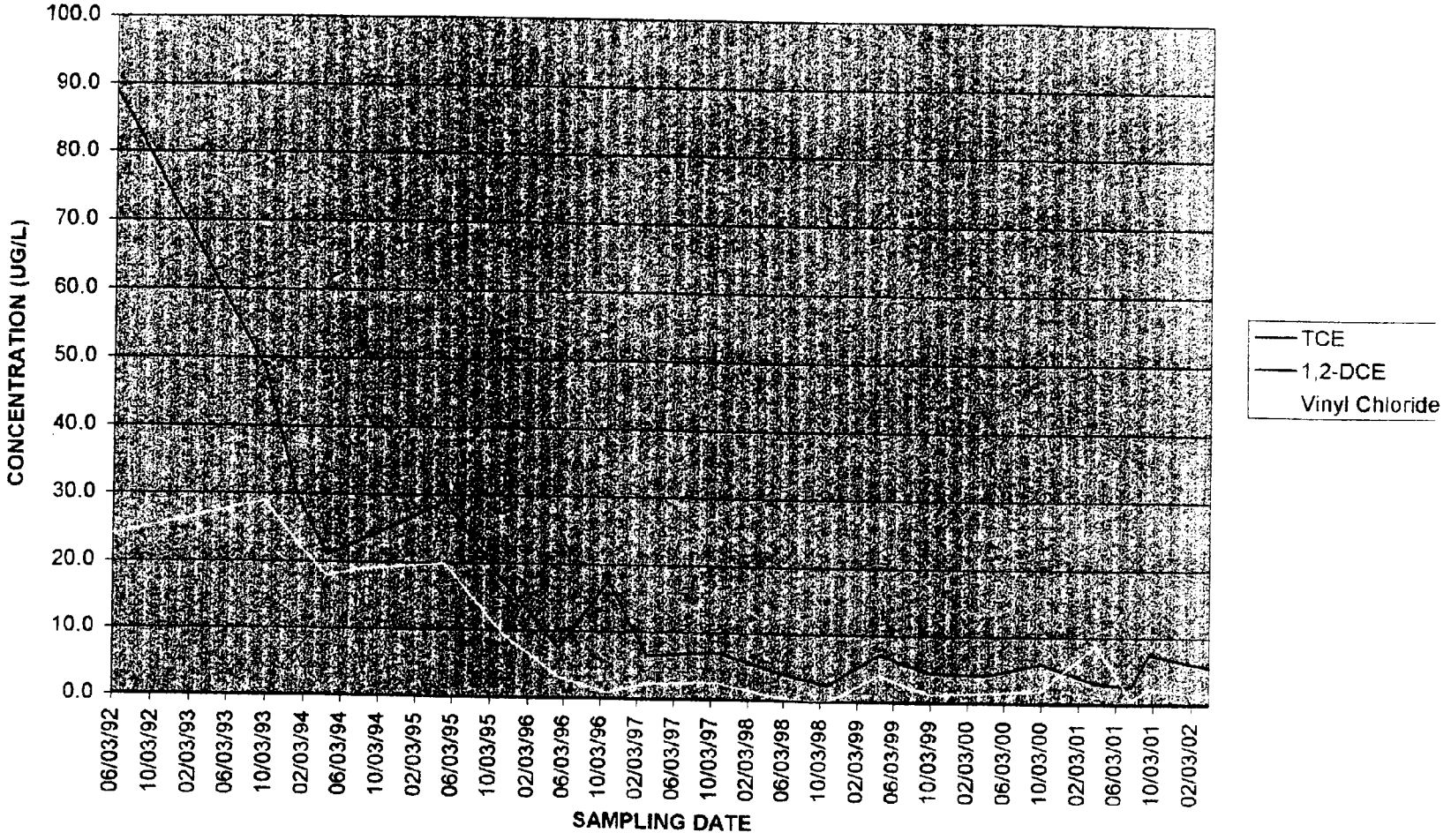


FIGURE 5 - LOG NORMAL CONCENTRATIONS OF VINYL CHLORIDE AND CIS-1,2-DICHLOROETHENE VERSUS TIME SINCE REMOVAL ACTION FOR THE DISCHARGE

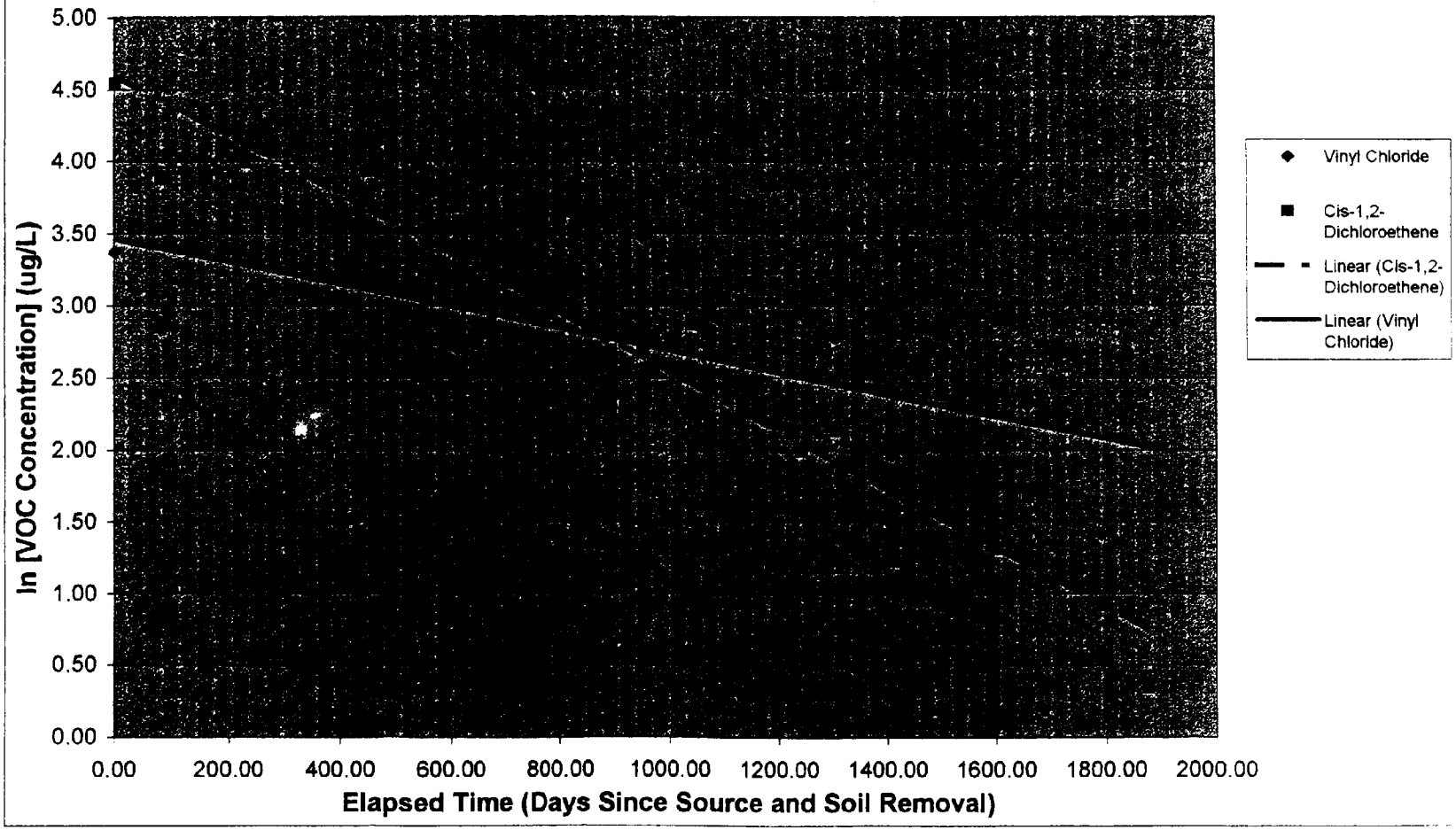


FIGURE 6 - LOG NORMAL CONCENTRATIONS OF VINYL CHLORIDE AND CIS-1,2-DICHLOROETHENE IN WELL MW-14A

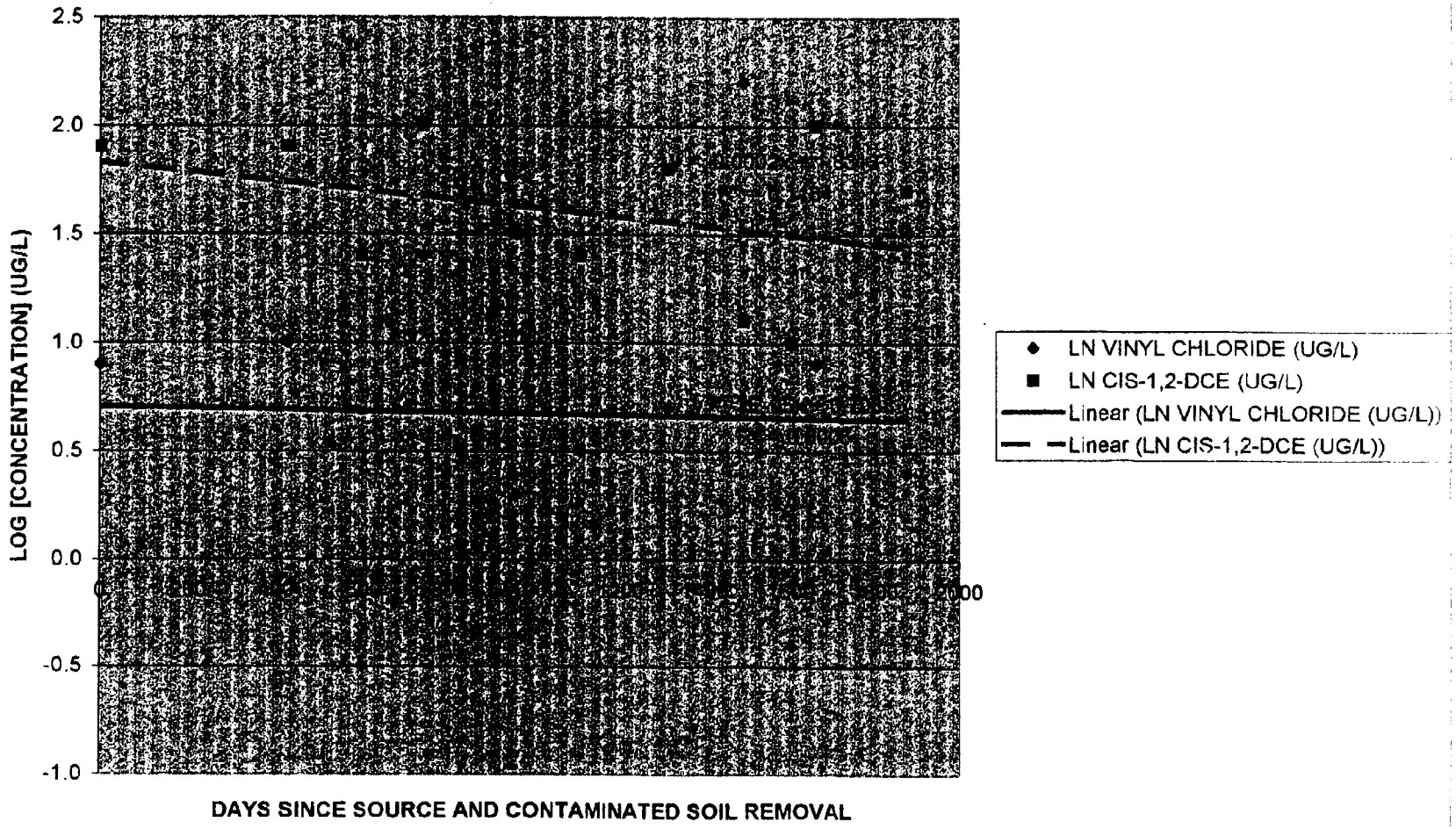


FIGURE 7 - LEAD CONCENTRATIONS VERSUS TIME FOR THE DISCHARGE

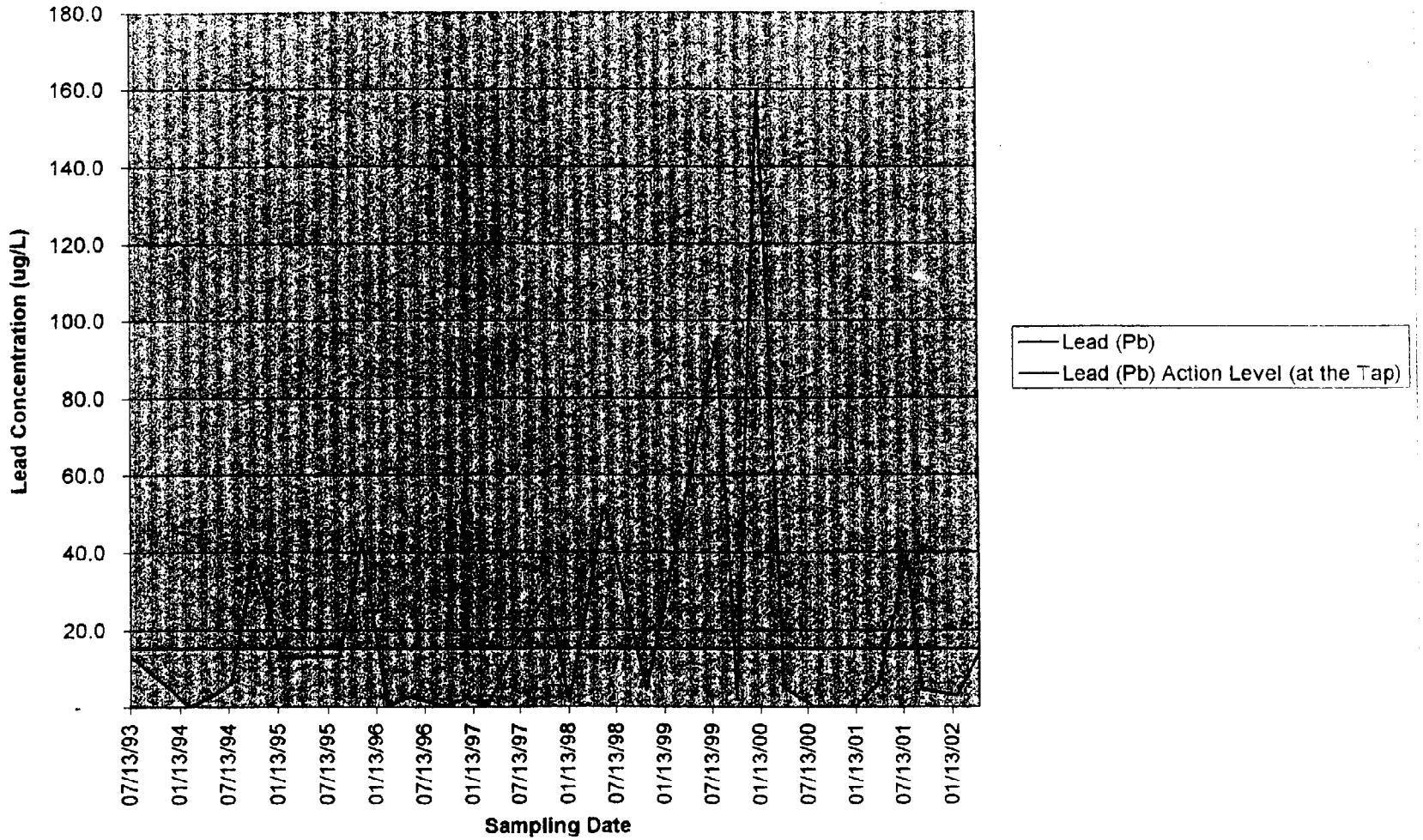
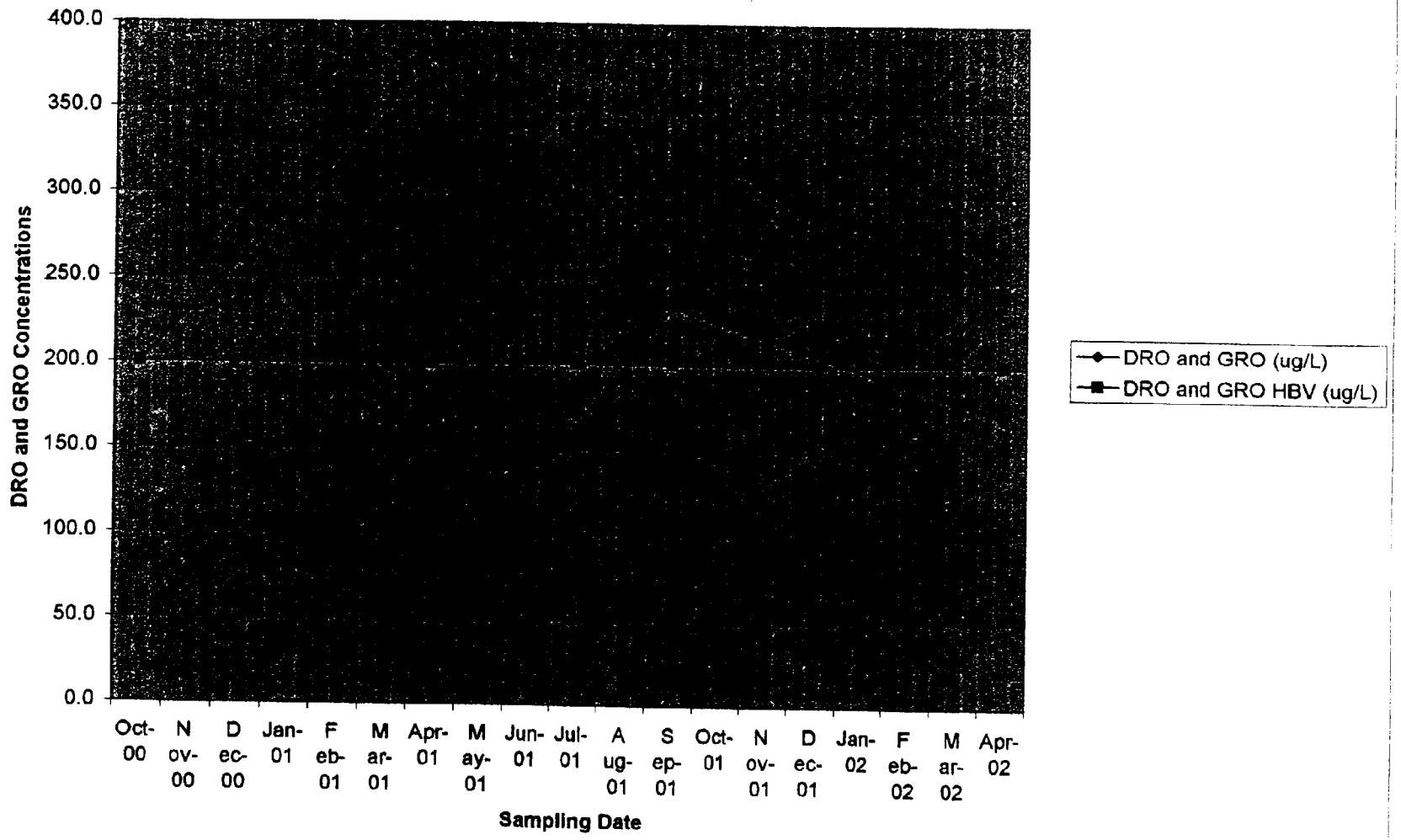
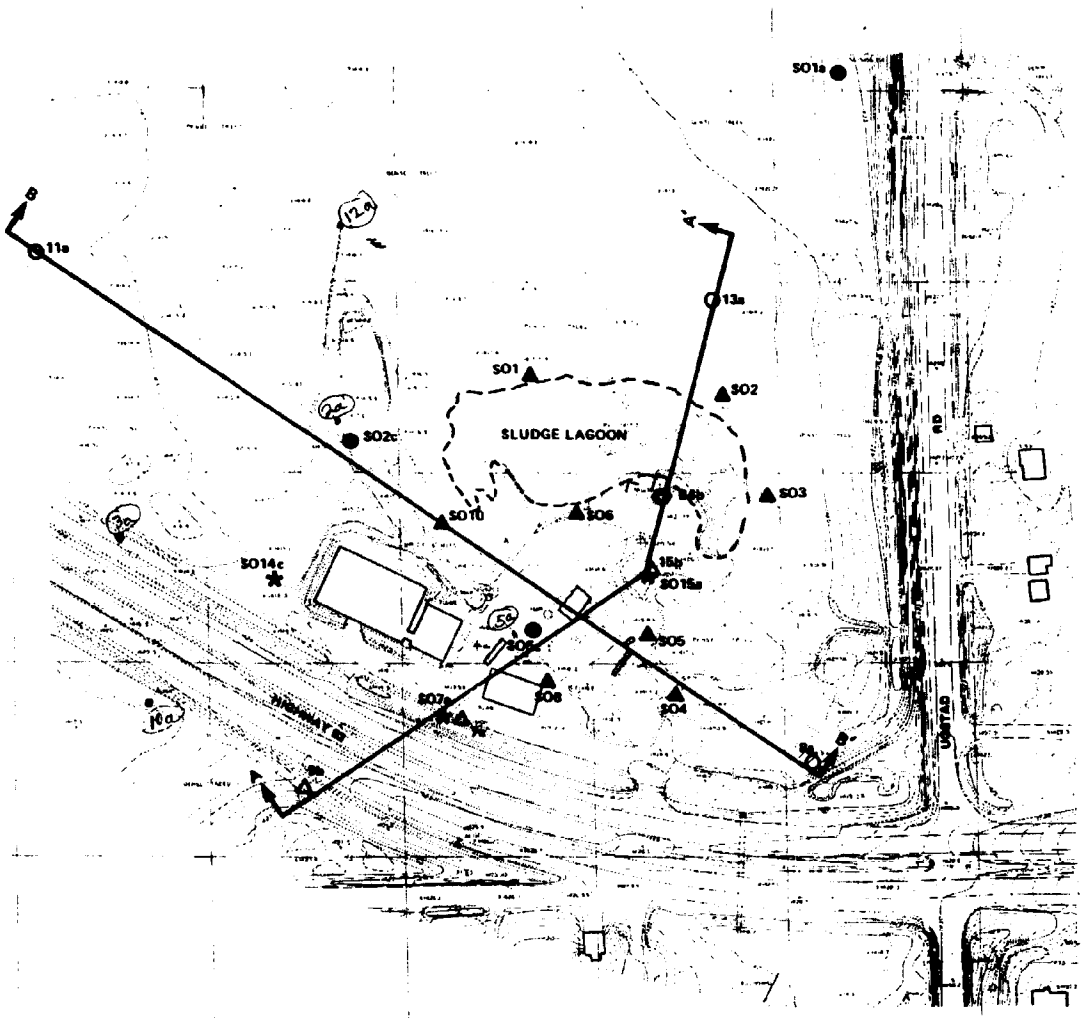
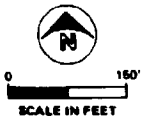


FIGURE 8 - DRO AND GRO CONCENTRATION DATA FOR WELL MPCA-4A







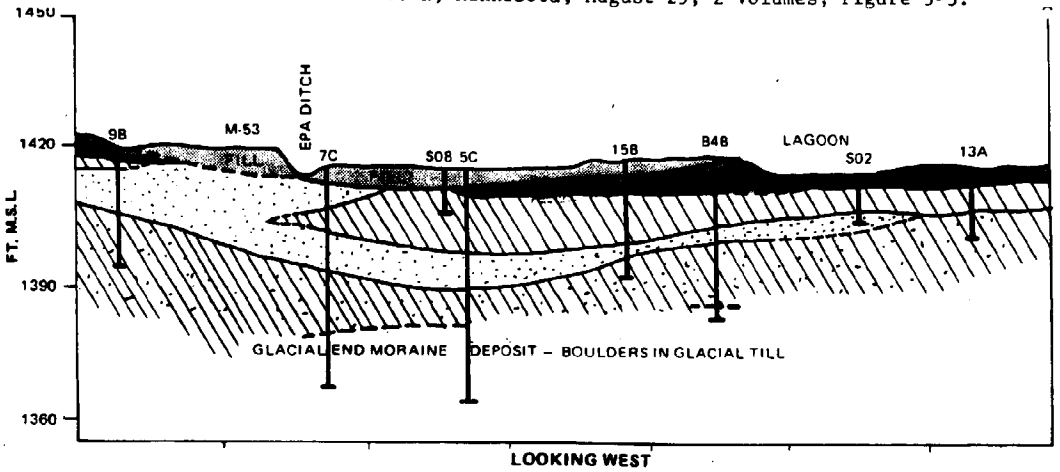
LEGEND

- PHASE I SOIL BORING MONITORING WELL INSTALLED
- PHASE II SOIL BORING
- PHASE II SOIL BORING MONITORING WELL INSTALLED
- PHASE I WELLS
- PHASE II WELLS
- WELLS FROM PREVIOUS INVESTIGATIONS

FROM: CH2M Hill; Black & Veatch; ICF; PRC; and Ecology and Environment, 1986. Public Comment, Remdial Investigation Report, Arrowhead Refinery Site, Hermantown, Minnesota, August 25, 2 Volumes, Figure 3-2.

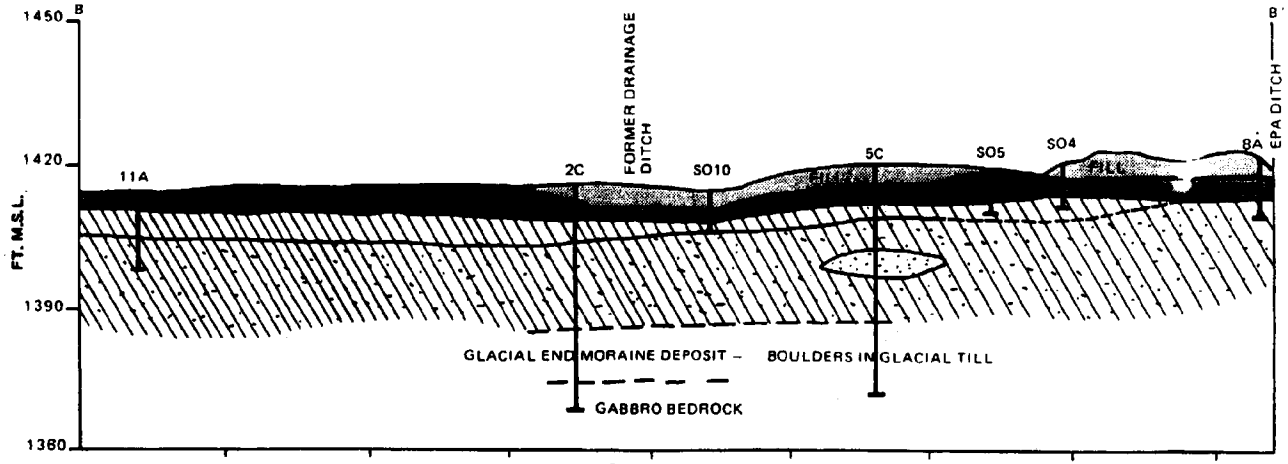
FIGURE 9.
LOCATION OF CROSS SECTION A-A' AND B-B'
ARROWHEAD REFINERY RI

FROM: CH2M Hill; Black & Veatch; ICF; PRC; and Ecology and Environment, 1986, Public Comment, Remedial Investigation Report, Arrowhead Refinery Site, Hermantown, Minnesota, August 25, 2 Volumes, Figure 3-3.



NOTE:
The depth and thickness of the subsurface strata indicated on these sections were generalized from and interpolated between test borings. Information on actual subsurface conditions exists only at the specific locations and dates indicated. Soil (rock) conditions and water levels at other locations may differ from conditions occurring at the boring locations. Also, the passage of time may result in a change in the conditions at these boring locations.

LEGEND
SO8 BORING/WELL NUMBER
BOTTOM OF BORING



SCALE IN FEET
HORIZONTAL 1" = 150'
VERTICAL 1" = 30'

LEGEND
SILT AND CLAY
SAND AND GRAVEL
INTERBEDDED CLAY, SILT, SAND AND GRAVEL
} GLACIAL OUTWASH DEPOSITS

FIGURE 10.
GENERALIZED GEOLOGIC CROSS SECTIONS
ARROWHEAD REFINERY RI

Table 1
Arrowhead Ground Water Analytical Data Summary

	Arrowhead Ground Water												
	Black = Not Monitored												
	U = Unfiltered; F = Filtered												
		Jun-92	Sep-93	Jan-94	Apr-94	Jul-94	May-95	Nov-95	May-96	Oct-96	Mar-97	Jun-97	Oct-97
1A	Lead - U	<	14.0	8.5	<	16.0	<						
	Lead - F	<	<	<	<	<	<	<	<	<			<
	Bromodichloromethane												
	Chlorodibromomethane												
	Chloroform												
	Total Xylenes												
	VOCs												
	GRO												
	DRO												
MPCA-2A	Lead - U												
	Lead - F												
	1,2-DCE											<	<
	TCE											<	<
	VC											<	<
	Other VOCs											<	<
	GRO												
	DRO												
3A	Lead - U	<	<	9.7	<	11.9	8.9						
	Lead - F	<	<	<	<	<	<	<	<	2.4	<		<
	1,2-DCE	<	<	<	<	<	<	1.0	0.7	0.8	1.0		0.7
	TCE	<	<	<	<	<	<	<	<	<	<		<
	VC	<	<	<	<	<	<	<	<	<	<		<
	Toluene												
	Total Xylenes												
	Other VOCs												
	GRO												
	DRO												
3B	Lead - U	<	4.1	5.4	<	<	<						
	Lead - F	<	<	<	<	<	<	<	<	<	1.4		<
	VOCs												
	GRO												
	DRO												
B4b	Lead - U	<	140.0		7.6	<	288.0						
	Lead - F	8.0	<		<	<	<						
	1,2-DCE	<	6.0		<	<	<						
	TCE	10.0	1.0		<	<	<						
	VC	<	<		<	<	<						

Table 1
Arrowhead Ground Water Analytical Data Summary

		Jun-92	Sep-93	Jan-94	Apr-94	Jul-94	May-95	Nov-95	May-96	Oct-96	Mar-97	Jun-97	Oct-97
5A	Lead - U	<	325.0		78.6								
	Lead - F	10.0	<		<								
	1,2-DCE	240.0	420.0		1,100.0								
	TCE	38.0	350.0		420.0								
	VC	95.0	<		3,000.0								
5B	Lead - U	<	6.7	41.8	<	5.4	<						
	Lead - F	6.0	<	<	<	<	<	<	<				
	1,2-DCE	80.0	3,300.0	2,900.0	690.0	3,100.0	56.0	5.2	15.0				
	TCE	<	<	59.0	<	<	<	<	0.2				
	VC	9.0	290.0	2,100.0	110.0	500.0	20.0	10.0	15.0				
5C	Lead - U	<	<	<	<	<	<						
	Lead - F	<	<	<	<	<	<	<	<				
	1,2-DCE	7.0	23.0	6.0	<	5.0		0.3	<				
	TCE	<	<	<	<	<		<	<				
	VC	<	<	<	<	<		<	<				
5E	Lead - U	<	6.5	<	11.3	<	<						
	Lead - F	<	<	<	<	<	<	<	<				
MPCA-4A	Lead - U												
	Lead - F											<	<
	1,2-DCE											<	<
	TCE											3.0	<
	VC											<	<
	Acetone											3,300.0	6,800.0
	Chloroethane											13.0	8.0
	Chloroform												
	1,1-Dichloroethane												
	1,2-DCA											3.0	3.0
	1,2-Dichloropropane												
	Ethyl Ether											32.0	30.0
	Methylene Chloride											**15.0**	**8.0**
	Methyl Ethyl Ketone											360.0	680.0
	Methyl Isobutyl Ketone											660.0	150.0
	Benzene												
	Ethylbenzene												
	Toluene											4.0	2.0
	Xylenes											2.0	<
	n-Propylbenzene												
	1,2,4-Trimethylbenzene												
	1,3,5-Trimethylbenzene												
	GRO												
	DRO												
	GRO + DRO												
	2-Methyl-3-Pentanone												

Table 1
Arrowhead Ground Water Analytical Data Summary

		Jun-92	Sep-93	Jan-94	Apr-94	Jul-94	May-95	Nov-95	May-96	Oct-96	Mar-97	Jun-97	Oct-97
	3-Methyl-2-Pentanone												
	2-Pentanone												
	Isopropryl Chloride												
	Methyl Isopropyl Ketone												
	Dichlorodifluoromethane												
	Various ketones as TICs												
	Other VOCs												
	2-Methylnaphthalene												
	Naphthalene											0.320	0.095
	Phenanthrene												0.086
	Fluoranthene												0.049
MPCA-4B	Lead - U												0.013
	Lead - F												
	1,2-DCE											<	<
	TCE											<	<
	VC											<	<
	Acetone											<	<
	Methyl Isobutyl Ketone											45.0	<
	Toluene											8.2	<
	Xylenes												0.7
	Methyl Ethyl Ketone												0.7
	Naphthalene												
	Other VOCs												0.039
	GRO												
	DRO												
MPCA-5A	Lead - U												
	Lead - F												
	1,2-DCE											<	<
	TCE											**296.0**	**253.4**
	VC											**37.0**	**23.0**
	1,1-DCE											**86.0**	**19.0**
	Chloroethane											3.2	1.8
	Chloroform												
	Dichlorodifluoromethane												
	cis-1,3-Dichloropropene											<	<
	1,1,1-Trichloroethane											<	<
	Toluene											<	<
	Other VOCs												
	GRO												
	DRO												
MPCA-5B	Lead - U												
	Lead - F												
	1,2-DCE											<	1.4
												70.0	60.0

Table 1
Arrowhead Ground Water Analytical Data Summary

		Jun-92	Sep-9?	Jan-94	Apr-94	Jul-94	May-95	Nov-95	May-96	Oct-96	Mar-97	Jun-97	Oct-97
	TCE	[redacted]										0.9	1.0
	VC											37.0	93.0
	Chloroethane												
	1,1-Dichloroethane												
	1,2-Dichloroethane												
	1,1-Dichloroethene												
	Ethyl Ether												
	Benzene											1.1	2.4
	Ethylbenzene												
	Toluene											0.2	1.9
	Xylenes											0.3	2.2
	Other VOCs												
	GRO												
	DRO												
8A	Lead - U	<	<	6.0	<	13.5	33.3						
	Lead - F	<	<	<	<	<	<	<	<	<	<		<
	Chloroform												
	Acetone												
	Total Xylenes												
	VOCs												
	GRO												
	DRO												
8B	Lead - U	<	<	3.2	<	<	<						
	Lead - F	<	<	<	<	3.1	<	<	<	<	1.4		<
	Dichlorodifluoromethane												
	Ethyl ether												
	Toluene												
	Total Xylenes												
	Other VOCs												
	GRO												
	DRO												
9A	Lead - U	<	8.2	<	<	<	8.4						
	Lead - F	7.0	<	<	<	<	<	<	<	<	<		<
	Acetone												
	VOCs												
	GRO												
	DRO												
9B	Lead - U	<	18.4	8.9	<	<	<						
	Lead - F	<	<	<	<	<	<	<	<	1.5	<		<
	Acetone												
	Toluene												
	VOCs												
	GRO												

Table 1
Arrowhead Ground Water Analytical Data Summary

		Jun-92	Sep-93	Jan-94	Apr-94	Jul-94	May-95	Nov-95	May-96	Oct-96	Mar-97	Jun-97	Oct-97
	DRO												
10A	Lead - U	<	3.1	<	<	<	<						
	Lead - F	<	<	<	<	<	<	<	<	4.5	<		<
	VOCs												
	GRO												
	DRO												
10B	Lead - U	<	4.0	<	<	5.5	<						
	Lead - F	<	<	<	4.3	<	<	<	<	<	<		<
	Bromomethane												
	Toluene												
	Other VOCs												
	GRO												
	DRO												
14A	Lead - U	<	<	26.9	<	4.9	<						
	Lead - F	<	<	<	<	<	<	<	<	1.8	<		<
	1,2-DCE	89.0	48.0	30.0	21.0	23.0	29.0	17.0	7.3	17.6	6.5		7.0
	TCE	<	<	<	<	<	<	0.1	<	<	<		<
	Vinyl Chloride	**24.0**	**29.0**	**23.0**	**18.0**	**19.0**	**20.0**	**9.3**	**3.2**	**1.0**	**2.4**		**2.6**
	Benzene												
	Chloroethane												
	Dichlorodifluormethane												
	Toluene												
	Total Xylenes												
	Other VOCs												
	GRO												
	DRO												
14B	Lead - U	<	4.0	10.6	<	3.7	<						
	Lead - F	<	<	<	<	<	<	<	<	<	<		<
	Benzene												
	Chloroform												
	Total-1,2-Dichloroethene												
	Toluene												
	Trichloroethene												
	Vinyl Chloride												
	Total Xylenes												
	Other VOCs												
	GRO												
	DRO												
14C	Lead - U												
	Lead - F										<		<
	Toluene												
	Total Xylenes												
	Other VOCs												

Table 1
Arrowhead Ground Water Analytical Data Summary

		Jun-92	Sep-93	Jan-94	Apr-94	Jul-94	May-95	Nov-95	May-96	Oct-96	Mar-97	Jun-97	Oct-97
	GRO												
	DRO												
16S	Lead - U	<	13.2	9.3	<	19.8	<						
	Lead - F	<	<	<	<	<	<	<	<	1.7	<		<
	Benz(a)anthracene	<	<	<	<	<	<	<	<	0.016	0.028		0.018
	Benzo(a)pyrene	<	<	<	<	<	<	<	<	<	0.015		0.011
	Benzo(b&j)fluoranthene	<	<	<	<	<	<	<	<	<	0.016		
	Benzo(e)pyrene	<	<	<	<	<	<	<	<	<	0.013		
	Benzo(g,h,I)perylene	<	<	<	<	<	<	<	<	<	0.014		
	Chrysene	<	<	<	<	<	<	<	<	<	0.017		0.011
	Indeno(1,2,3-cd)pyrene	<	<	<	<	<	<	<	<	<	0.019		0.012
	Total c-PAH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.122	0.0	0.052
	Fluoranthene												0.025
	Phenanthrene												0.012
	Pyrene												0.026
17S	Lead - F												
	1,1,1-Trichloroethane												
	Toluene												
	Total Xylenes												
	Other VOCs												
	GRO												
	DRO												
17B	Lead - F												
	Toluene												
	Total Xylenes												
	TIC of Propanoic Acid												
	Other VOCs												
	GRO												
	DRO												
17E	Lead - F												
	VOCs												
	GRO												
	DRO												
18E	Lead - U												
	Lead - F												1.2
	1,2-DCE												<
	TCE												<
	VC												<
	Methyl Isobutyl Ketone												5.4
Field Blank	Lead												
	Acetone												
	Bromodichloromethane												

Table 1
Arrowhead Ground Water Analytical Data Summary

		Jun-92	Sep-93	Jan-94	Apr-94	Jul-94	May-95	Nov-95	May-96	Oct-96	Mar-97	Jun-97	Oct-97
	Chlorodibromomethane												
	Chloroform												
	Toluene												
	Total Xylenes												
	TICs - Isobutylene												
	TICs - Propanoic Acid												
	Other VOCs												
	GRO												
	DRO												
Trip Blank	Bromodichloromethane												
	Chloroform												
	Acetone												
	VOCs												
	GRO												
	DRO												

Table 1
Arrowhead Ground Water Analytical Data Summary

	Arrowhead Ground Water											
	Black = Not Monitored											
	U = Unfiltered; F = Filtered											
		May-98	Oct-98	Oct-98	Apr-99	Oct-99	Apr-00	Oct-00	Apr-01	Jul-01	Sep-01	Apr-02
1A	Lead - U						Not					
	Lead - F	<	<	<	<1.0	<1.0	Sampled	<1.0	<1.0		<1.0	<1.0
	Bromodichloromethane								1.4		<0.2	<0.2
	Chlorodibromomethane								P<0.5		<0.5	<0.5
	Chloroform								5.0		<0.1	<0.1
	Total Xylenes										P<0.2	<0.2
	VOCs				<	<	Frozen	<	<		<	<
	GRO							<40	<40		<40	<40
	DRO							<80	<80		<80	<80
MPCA-2A	Lead - U											
	Lead - F	<	<	<	Not Samp.	Not Samp.	Not Samp.	Not Samp.	Not Samp.		1.4	<1.0
	1,2-DCE	<	<	<	Not Samp.	Not Samp.	Not Samp.	Not Samp.	Not Samp.		<0.2	<0.2
	TCE	<	<	<	Not Samp.	Not Samp.	Not Samp.	Not Samp.	Not Samp.		<0.1	<0.1
	VC	<	<	<	Not Samp.	Not Samp.	Not Samp.	Not Samp.	Not Samp.		<0.5	<0.5
	Other VOCs										<	<
	GRO											<40
	DRO										<80	<80
3A	Lead - U											
	Lead - F	<	<	<	<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	1.7/2.0		<1.0/<1.0	2.4/2.7
	1,2-DCE	0.3	<	<	<0.2	0.3/0.3	1.2/1.1	0.3/0.3	P<0.2/P<0.2		0.4/0.4	P<0.2/P<0.2
	TCE	<	<	<	<0.1	<0.1/<0.1	<0.1<1.0	<0.1/<0.1	<0.1/<0.1		<0.1/<0.1	<0.1/<0.1
	VC	<	<	<	<0.5	<0.5/<0.5	<0.5<0.5	<0.5/<0.5	<0.5/<0.5		<0.5/<0.5	<0.1/<0.1
	Toluene						0.7/0.7	<0.2/<0.2	<0.2/<0.2		<0.2/<0.2	<0.5/<0.5
	Total Xylenes										P<0.2B/<0.2	<0.2<0.2
	Other VOCs				<	<	</<	</<	</<		</<	<
	GRO							<40/<40	NA/NA		NA	NA
	DRO							<80/<80	<80/<80		<80/<80	<80/<80
3B	Lead - U											
	Lead - F	<	<	<	<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0
	VOCs				<	<	<	<	<		<	<
	GRO							<40	NA		NA	NA
	DRO							<80	<80		<80	<80
B4b	Lead - U											
	Lead - F											
	1,2-DCE											
	TCE											
	VC											

Table 1
Arrowhead Ground Water Analytical Data Summary

		May-98	Oct-98	Oct-98	Apr-99	Oct-99	Apr-00	Oct-00	Apr-01	Jul-01	Sep-01	Apr-02
5A	Lead - U	[redacted]										
	Lead - F											
	1,2-DCE											
	TCE											
	VC											
5B	Lead - U											
	Lead - F											
	1,2-DCE											
	TCE											
	VC											
5C	Lead - U											
	Lead - F											
	1,2-DCE											
	TCE											
	VC											
5E	Lead - U											
	Lead - F											
MPCA-4A	Lead - U											
	Lead - F	<			<1.0	<1.0	<1.0	<1.0/<1.0	<1.0	NA	NA	<1.0
	1,2-DCE	<	<	<	<1.0	<0.2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.2
	TCE	2.0	3.4	3.4	3.0	2.8	2.0	1.2	1.1	1.4	0.8	1.2
	VC	<	<	<	<3.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Acetone	4,600.0	580.0	580.0	<100	64.0	35B	150	27	<20	P<20	<20
	Chloroethane	<	7.8	7.8	14.0	1.9	1.1	2.9	3.3	1.5	2.8	0.8
	Chloroform				<0.5	P<0.1B	0.1B	<0.1	<0.1	<0.1	<0.1	<0.1
	1,1-Dichloroethane				<1.0	P<0.2	0.2	<0.2	0.3	P<0.2	0.2	P<0.2
	1,2-DCA	2.0	0.7	0.7	1.0	0.4	0.3	0.3	1.9	0.5	1.0	0.6
	1,2-Dichloropropane				<1.0	P<0.2	<0.2	<0.2	P<0.2	P<0.2	P<0.2	<0.2
	Ethyl Ether	31.0	4.3	4.3	<10	<2.0	<2.0	<2.0	6.3	P<2.0	3.7	P<0.2
	Methylene Chloride	<	1.7	1.7	P<3.0	P<0.5	<0.5	P<0.5	2.8	<0.5	1.5	0.6
	Methyl Ethyl Ketone	460.0	77.0	77.0	100.0	10.0	<10	26.0	P<10	<10	<10	<10
	Methyl Isobutyl Ketone	220.0	37.0	37.0	32.0	16.0	9.3	13.0	82.0	27.0	53.0	33.0
	Benzene	67.0	6.9	6.9	1.0	1.1	0.2	0.5	2.6	1.5	1.5	1.0/1.4
	Ethylbenzene				<1.0	P<0.2	<0.2	<0.2	<0.2	<0.2	P<0.2	<0.2
	Toluene	2.0	0.9	0.9	1.0B	0.4	<0.2	<0.2	0.4	0.5	0.6	<0.2
	Xylenes	<	1.1	1.1	<1.0	0.4	<0.2	<0.2	P<0.2	0.3	0.6	<0.2
	n-Propylbenzene				<3.0	P<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1,2,4-Trimethylbenzene				<3.0	P<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1,3,5-Trimethylbenzene				<3.0	P<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	GRO							<40/<40	**170**	<40	**74.0**	**68.0**
	DRO							200 / 160	**210**	170.0	**160.0**	**140.0**
	GRO + DRO							200.0	**380**	170.0	234.0	**170.0**
	2-Methyl-3-Pentanone								46	8.0	ND	ND

Table 1
Arrowhead Ground Water Analytical Data Summary

		May-98	Oct-98	Oct-98	Apr-99	Oct-99	Apr-00	Oct-00	Apr-01	Jul-01	Sep-01	Apr-02
	3-Methyl-2-Pentanone								9.22	3.0	4.0	ND
	2-Pentanone								14		ND	ND
	Isopropryl Chloride									9.0	ND	ND
	Methyl Isopropyl Ketone									2.5	ND	ND
	Dichlorodifluoromethane											P<0.5
	Various ketones as TICs											4 - 16
	Other VOCs									<	<	<
	2-Methylnaphthalene							N.A.		NA	NA	NA
	Naphthalene					0.6	<0.5	<0.5		<0.5	<0.5	NA
	Phenanthrene							N.A.		NA	NA	NA
	Fluoranthene							N.A.		NA	NA	NA
MPCA-4B	Lead - U											
	Lead - F	2.6			<1.0	<1.0	2.4B	<1.0	<1.0	NA	<1.0	1.4
	1,2-DCE	<	<	<	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	TCE	<	<	<	<1.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	VC	<	<	<	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Acetone	<	<	<	<20	<20	<20	<20	<20	<20	<20	<20
	Methyl Isobutyl Ketone	<	<	<	<5.0	<5.0	<5.0	<5.0	<5.0	<5	<5.0	<5.0
	Toluene	<	<	<	0.2B	<0.2	<0.2	<0.2	0.2	P<0.2	P<0.2	<0.2
	Xylenes	<	<	<	<0.2	<0.2	<0.2	P<0.2	P<0.2	<0.2	P<0.2	<0.2
	Methyl Ethyl Ketone				P<10	<10	<10	<10	<10	<10	<10	<10
	Naphthalene	<	<	<	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Other VOCs				<	<	<	2 TICs	1TIC	1 TIC	1 TIC	2 TICs
	GRO							<40	<40	<40	<40	<40
	DRO							<80	<80	<80	<80	<80
MPCA-5A	Lead - U											
	Lead - F	<	<	<	<1.0	<1.0/<1.0	<1.0/<1.0	Not	5.5/2.0	NA	<1.0/1.2	<1.0<1.0
	1,2-DCE	**55.9**	**25.9**	25.9	5.6/6.4	1.6/1.8	2.2/2.3	Sampled	0.6/0.6	0.4	0.4/0.6	0.3/0.3
	TCE	**7.8**	**4.4**	4.4	1.0/1.1	0.7/0.7	0.5/0.5	Cap is	0.3/0.3	0.3	0.3/0.3	0.2/0.2
	VC	**24.0**	**3.4**	3.4	7.0/4.2	0.7/P<0.5	3.1/2.9	stuck on.	<0.5/<0.5	<0.5	<0.5/<0.5	<0.5/<0.5
	1,1-DCE	<	<	<	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5		<0.5/<0.5	<0.5	<0.5/<0.5	<0.5/<0.5
	Chloroethane				4.7/5.3	3.0/1.9	2.7/2.6		P<0.5/P<0.5	P<0.5	<0.5/<0.5	<0.5/<0.5
	Chloroform				<0.1	0.1B/0.1B	<0.1<0.1		P<0.5/P<0.5	<0.1	<0.1/<0.1	<0.1/<0.1
	Dichlorodifluoromethane	<	1.5	1.5	<0.5/<0.5	<0.5/<0.5	<0.5<0.5		<0.5/<0.5	<0.5	<0.5/<0.5	<0.5/<0.5
	cis-1,3-Dichloropropene	<	0.3	0.3	<0.2/<0.2	<0.2/<0.2	<0.2/<0.2		<0.2/<0.2	<0.2	<0.2/<0.2	<0.2/<0.2
	1,1,1-Trichloroethane	<	0.2	0.2	<0.2/<0.2	<0.2/<0.2	<0.2/<0.2		<0.2/<0.2	<0.2	<0.2/<0.2	<0.2/<0.2
	Toluene									0.3	<0.2	<0.2<0.2
	Other VOCs									<	<	</<
	GRO								<40	<40	<40/<40	<40/<40
	DRO								<80	<80	<80/<80	<80/<80
MPCA-5B	Lead - U											
	Lead - F	<	<	<	<1.0	<1.0	<1.0	<1.0	<1.0	NA	<1.0	<1.0
	1,2-DCE	27.6	27.9	27.9	14.4	6.2	1.0	P<0.2	P<0.2	P<0.2/<0.2	<0.2	<0.2

Table 1
Arrowhead Ground Water Analytical Data Summary

		May-98	Oct-98	Oct-98	Apr-99	Oct-99	Apr-00	Oct-00	Apr-01	Jul-01	Sep-01	Apr-02
	TCE	1.1	4.6	4.6	2.3	2.5	0.3	0.1	P<0.1	0.1/0.2	<0.1	<0.1
	VC	25.0	3.5	3.5	43.0	6.7	1.5	<0.5	<0.5	<0.5/<0.5	<0.5	<0.5
	Chloroethane				0.7	<0.5	1.2	P<0.5	P<0.5	P<0.5/P<0.5	0.6	P<0.5
	1,1-Dichloroethane				0.2	<0.2	0.2	<0.2	P<0.2	<0.2/<0.2	P<0.2	<0.2
	1,2-Dichloroethane				0.3	<0.2	<0.2	P<0.2	<0.2	P<0.2/P<0.2	0.2	P<0.2
	1,1-Dichloroethene				0.6	P<0.5	<0.5	<0.5	<0.5	<0.5/<0.5	<0.5	<0.5
	Ethyl Ether				P<2.0	<2.0	<2.0	<2.0	<2.0	<2.0/<2.0	<2.0	<2.0
	Benzene	1.3	1.0	1.0	1.4	0.9	0.7	0.3	0.3	0.3/0.3	0.3	0.3
	Ethylbenzene				P<0.2	<0.2	<0.2	P<0.2	<0.2	<0.2/<0.2	<0.2	<0.2
	Toluene	0.3	0.3	0.3	0.3B	<0.2	<0.2	P<0.2	0.2	0.3/P<0.2	P<0.2	<0.2
	Xylenes	0.5	0.4	0.4	0.2	<0.2	<0.2	P<0.2	P<0.2	P<0.2/<0.2	P<0.2	<0.2
	Other VOCs				<	<	<	3 TICs	1 TIC	1TIC/0 TIC	1TIC	2 TICs
	GRO							<40	<40	<40/<40	<40	<40
	DRO							130	<80	<80/<80	<80	<80
8A	Lead - U											
	Lead - F				<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	1.2
	Chloroform				<0.1	0.1B		<0.1	<0.1		<0.1	<0.1
	Acetone						45.0B	<20	<20		27.0	<20
	Total Xylenes										P<0.2B	<0.2
	VOCs				<	<		<	<		<	<
	GRO							<40	NA		NA	NA
	DRO							<80	<80		<80	<80
8B	Lead - U											
	Lead - F				<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0
	Dichlorodifluoromethane				14.0	12.0	8.4	9.0	<0.5		20.0	25.0
	Ethyl ether				3.5	P<2.0	3.0	3.6	<2.0		4.8	3.3
	Toluene								P<0.2		<0.2	<0.2
	Total Xylenes										P<0.2B	<0.2
	Other VOCs				<	<	<	<	<		<	<
	GRO							<40	NA		NA	NA
	DRO							<80	<80		<80	<80
9A	Lead - U											
	Lead - F	<	<	<	<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0
	Acetone						22.0B	<20	<20		<20	<20
	VOCs				<	<	<	<	<		<	<
	GRO							<40	NA		NA	Not Anal.
	DRO							<80	<80		<80	<80
9B	Lead - U											
	Lead - F	<	<	<	<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0
	Acetone						41.0B	<20	<20		<20	<20
	Toluene								P<0.2		<0.2	<0.2
	VOCs				<	<	<	<	<		<	<
	GRO							<40	NA		NA	Not Anal.

Table 1
Arrowhead Ground Water Analytical Data Summary

		May-98	Oct-98	Oct-98	Apr-99	Oct-99	Apr-00	Oct-00	Apr-01	Jul-01	Sep-01	Apr-02
	DRO							<80	<80		<80	<80
10A	Lead - U											
	Lead - F	<	<	<	<1.0	<1.0	<1.0	1.4	1.0		<1.0	<1.0
	VOCs				<	<	<	<	<		<	<
	GRO							<40	NA		NA	Not Anal.
	DRO							<80	<80		<80	<80
10B	Lead - U											
	Lead - F	<	<	<	<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0
	Bromomethane											P<0.5
	Toluene				0.2B	<0.2	<0.2	<0.2	<0.2		<0.2	<0.2
	Other VOCs				<	<	<	<	<		<	1 TIC
	GRO							<40	NA		NA	Not Anal.
	DRO							<80	<80		<80	<80
14A	Lead - U											
	Lead - F	<	<	<	<1.0	<1.0	<1.0	<1.0	<1.0/<1.0?	NA	<1.0	<1.0
	1,2-DCE	4.2	2.4	2.4	7.1	4.4	4.2	5.9	<0.3/3.1?	2.6	7.5	5.5
	TCE	<	<	<	0.1	0.1	<0.1	0.1	<0.1/0.1?	P<0.1	0.1	0.1
	Vinyl Chloride	**0.6**	<	<	4.1	1.4	1.7	2.0	<0.5/9.0?	0.7	2.5	1.5
	Benzene				0.3	0.2	<0.2	0.3	<1.0/P<0.2?	0.2	0.5	0.5
	Chloroethane				P<0.5	<0.5	<0.5	<0.5	<0.5/<0.5?	<0.5	<0.5	<0.5
	Dichlorodifluormethane				P<0.5	P<0.5	<0.5	<0.5	<0.5/<0.5?	<0.5	<0.5	<0.5
	Toluene				0.2B	<0.2	<0.2	<0.2	P<0.2/<0.2?	0.2	<0.2	<0.2
	Total Xylenes									P<0.2	<0.2	<0.2
	Other VOCs				<	<	<	<	</<?	<	<	<
	GRO							<40	<40/<40?	<40	<40	<40
	DRO							<80	<80/<80?	<80	<80	<80
14B	Lead - U											
	Lead - F	<	<	<	<1.0	<1.0	<1.0	<1.0	<1.0	NA	<1.0	2.4
	Benzene								0.3	P<0.2	<0.2	<0.2
	Chloroform				<0.1	0.1B	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Total-1,2-Dichloroethene								5.0	<0.3	<0.3	<0.2
	Toluene									0.4	P<0.2	<0.2
	Trichloroethene								0.1	<0.1	<0.1	<0.1
	Vinyl Chloride								1.4	<0.5	<0.5	<0.5
	Total Xylenes									0.4	P<0.2	<0.2
	Other VOCs				<	<	<	<	<	<	<	1 TIC
	GRO							<40	<40	<40	<40	<40
	DRO							160	<80	<80	<80	<80
14C	Lead - U											
	Lead - F	<	<	<	<1.0	<1.0	<1.0	<1.0	<1.0	NA	<1.0	3.4
	Toluene				0.2B	<0.2	<0.2	<0.2	<0.2	P<0.2	<0.2	<0.2
	Total Xylenes									P<0.2	P<0.2B	<0.2
	Other VOCs				<	<	<	<	<	<	<	<

Table 1
Arrowhead Ground Water Analytical Data Summary

		May-98	Oct-98	Oct-98	Apr-99	Oct-99	Apr-00	Oct-00	Apr-01	Jul-01	Sep-01	Apr-02
	GRO							<40	<40	<40	<40	<40
	DRO							<80	<80	<80	<80	<80
16S	Lead - U				Not Samp.	Not Samp.	Not Samp.	Not Samp.	Not Samp.			
	Lead - F				Not Samp.	Not Samp.	Not Samp.	Not Samp.	Not Samp.			
	Benz(a)anthracene											
	Benzo(a)pyrene											
	Benzo(b&j)fluoranthene											
	Benzo(e)pyrene											
	Benzo(g,h,i)perylene											
	Chrysene											
	Indeno(1,2,3-cd)pyrene											
	Total c-PAH											
	Fluoranthene											
	Phenanthrene											
	Pyrene											
17S	Lead - F							310R/<1.0	<1.0		<1.0	<1.0
	1,1,1-Trichloroethane							0.2	0.2		P<0.2	<0.2
	Toluene								P<0.2		<0.2	<0.2
	Total Xylenes										P<0.2B	<0.2
	Other VOCs							<	<		<	<
	GRO							<40	NA		NA	Not Anal.
	DRO							<80	<80		<80	<80
17B	Lead - F							<1.0	<1.0		<1.0	<1.0
	Toluene							P<0.2	P<0.2		<0.2	<0.2
	Total Xylenes							P<0.2	<0.4		<0.2	<0.2
	TIC of Propanoic Acid							P<5.0B	<		ND	ND
	Other VOCs							<	<		<	<
	GRO							<40	Not Samp.		NA	Not Anal.
	DRO							<80	<80		<80	<80
17E	Lead - F							<1.0		NS	NS	NS
	VOCs							<		NS	NS	NS
	GRO							<40		NS	NS	NS
	DRO							<80		NS	NS	NS
18E	Lead - U				Not Samp.	Not Samp.	Not Samp.	Not Samp.	Not Samp.	NS	NS	NS
	Lead - F				Not Samp.	Not Samp.	Not Samp.	Not Samp.	Not Samp.	NS	NS	NS
	1,2-DCE				Not Samp.	Not Samp.	Not Samp.	Not Samp.	Not Samp.	NS	NS	NS
	TCE				Not Samp.	Not Samp.	Not Samp.	Not Samp.	Not Samp.	NS	NS	NS
	VC				Not Samp.	Not Samp.	Not Samp.	Not Samp.	Not Samp.	NS	NS	NS
	Methyl Isobutyl Ketone				Not Samp.	Not Samp.	Not Samp.	Not Samp.	Not Samp.	NS	NS	NS
Field Blank	Lead				<1.0	<1.0	1.7	<1.0	<1.0/<1.0?	NA	1.2	Not Anal.
	Acetone						22	<20	<20/<20?	<20	<20	<20
	Bromodichloromethane				3.3	4.1	2.6	3	<0.2/<0.2?	2.6	3.9	1.9

Table 1
Arrowhead Ground Water Analytical Data Summary

		May-98	Oct-98	Oct-98	Apr-99	Oct-99	Apr-00	Oct-00	Apr-01	Jul-01	Sep-01	Apr-02
	Chlorodibromomethane							P<0.5	<0.5/<0.5?	0.5	P<0.5	P<0..5
	Chloroform				11	22	18	17	<0.1/<0.1?	19	25	6.5
	Toluene				0.2	<0.2	<0.2	P<0.2	P<0.2/<0.2?	0.3	0.2	<0.2
	Total Xylenes							P<0.2	<2/<0.4?	0.2	0.3	<0.2
	TICs - Isobutylene							Conc. <1	None/None	ND	None	None
	TICs - Propanoic Acid							Conc. <1	None	ND	None	None
	Other VOCs				<	<	<	<	<	<	<	<
	GRO							<40	<40/<40	<40	<40	<40
	DRO							<80	<80/<80	<80	<80	Not Anal.
Trip Blank	Bromodichloromethane				<	4.8	34	<	<0.2	<0.2	<0.2	<0.2
	Chloroform				<	26	<0.1	<	<0.1	<0.1	<0.1	<0.1
	Acetone								45	55B (Preserv)	<20	64 (Preserv)
	VOCs				<	<	<	<	<	<	<	<
	GRO							<40	<40	NA	<40	<40
	DRO							<80	<80	<80	NA	NA

TABLE 2
Arrowhead Remediation Site Analytical Discharge Data

Arrowhead Discharge in ug/l (parts per billion)														
	07/13/93	12/17/93	02/14/94	04/21/94	07/21/94	10/13/94	01/26/95	04/13/95	08/24/95	11/17/95	02/22/96	05/17/96	09/26/96	12/16/96
DRO (Diesel)	<	<	<	<	137,000	105,000	<	313	17,000,000.0	9,400,000.0	<	<	84.0	53.0
GRO (Gasoline)	<	<	<	<	115,000	<	<	<	110,000	<	<	<	70.0	54.0
Bromomethane												1.6	<	<
Chloroethane												0.6	<	<
Chloromethane														
Benzene	1.4	<	<	1.1	6.2	2.7	<	1.5	160.0	1.7	1.0	2.2	2.6	3.4
Ethylbenzene	1.8	<	<	<	2.1	<	<	<	340.0	0.9	0.3	0.4	<	0.3
MTBE	<	<	<	<	<	<	<	<	<	<	<	<	9.9	9.4
Naphthalene	<	<	<	<	1.1	<	<	<	4,000.0	3.0	0.5	<	<	<
Toluene	8.0	<	<	1.4	5.7	<	<	<	370.0	0.8	<	<	<	0.3
1,2,4-Trimethylbenzene	4.0	<	<	<	3.4	<	<	<	4,300.0	5.1	0.5	<	2.6	1.3
1,3,5-Trimethylbenzene	1.6	<	<	<	<	<	<	<	1,100.0	1.6	<	<	1.1	<
o-xylene	6.3	<	<	<	3.0	<	<	<	350.0	1.1	<	0.2	<	0.2
p+m-xylene			<	<	6.7	<	<	<	1,100.0	0.9	<	<	1.7	0.3
p-isopropyltoluene														0.5
n-Butylbenzene														
1,1-Dichloroethene												0.8	<	1.2
1,2-Dichloroethene	5.3	<	<	21.0	63.5	143.0	91.0	134.3	300.0	151.7	121.4	111.2	140.0	162.1
In 1,2-Dichloroethene	1.7	0	0	3.0	4.2	5.0	4.5	4.9	5.7	5.0	4.8	4.7	4.9	5.1
1,1-Dichloroethane														
1,2-Dichloroethane	<	<	<	<	<	1.0	<	<	<	0.7	0.4	0.5	<	0.9
Trichloroethene	<	<	<	<	2.3	4.7	6.0	<	<	6.3	3.6	5.8	<	3.5
Methyl Isobutyl Ketone	<	<	<	<	<	1.4	<	<	<	<	<	<	<	<
Butyl Benzene	<	<	<	<	2.0	<	<	<	900.0	7.4	<	<	<	1.0
Vinyl Chloride	3.4	55.0	41.0	37.0	29.0	9.5	28.0	69.0	<	140.0	82.0	96.0	53.0	95.0
Sum BETX	17.5	<	<	2.5	23.7	2.7	<	1.5	2,320.0	5.4	1.3	2.8	4.3	4.5
Sum VOCs	33.5	55.0	41.0	63.5	129.2	167.3	129.5	209.7	12,925.7	326.2	214.5	224.0	215.8	284.5
Lead (Pb)	13.0	4.0	<	2.0	5.9	38.1	12.5	12.9	12.9	43.0		2.6		2.2

TABLE 2
Arrowhead Remediation Site Analytical Discharge Data

Arrowhead Discharge in ug/l (parts per billion)														
	03/04/97	06/26/97	10/22/97	01/13/98	05/27/98	11/03/98	Copy of 11/03/98	08/06/99	10/13/99	01/11/00	04/11/00	08/01/00	10/03/00	01/12/01
DRO (Diesel)	<	<	46.0	<	48.0	<	<	160.0	<40	220.0	<40	54.0	<80	<80
GRO (Gasoline)	55.0	90.0	49.0	59.0	41.0	<	<	<40	<40	56.0	<40	<40	<40	<40
Bromomethane	<	<	<		<	<	<	<	<	<	<	<	<	<0.5
Chloroethane	<	<	<	0.8	<	<	<	<	<	<	<	<	<	<0.5
Chloromethane	0.7	<	<	2.0	<	<	<	<	<	<	<	<	<	<0.5
Benzene	3.9	3.4	1.2	1.0	2.5	1.5	1.5	0.5	0.4	0.4	0.4	0.2	P<0.2	0.2
Ethylbenzene	0.3	1.0	<		0.5	<	<	<	<	<	<	1.2	<0.2	<0.2
MTBE	11.0	2.8	<	3.2	3.2	<	<	<	<	4.2	2.7	6.2	<2.0	<2.0
Naphthalene	<	3.9	<		<	<	<	<	<	<	<	<	<0.5	<0.5
Toluene	<	<	<		<	<	<	<	<	<	<	<	<0.2	<0.2
1,2,4-Trimethylbenzene	0.6	2.6	<		0.5	<	<	<	<	<	<	1.5	<0.5	<0.5
1,3,5-Trimethylbenzene	<	<	<		<	<	<	<	<	<	<	1.4	<0.5	<0.5
o-xylene	<	1.3	<		<	<	<	<	<	<	<	<	<1.0	<0.2
p+m-xylene	0.2	1.1	<		0.5	<	<	<	<	<	<	<	<1.0	<0.2
p-Isopropyltoluene	<	<	<		<	<	<	<	<	<	<	<	<0.5	<0.5
n-Butylbenzene		1.1	<		<	<	<	0.6	<	<	<	<	<0.5	<0.5
1,1-Dichloroethene	0.8	<	<	0.6	<	<	<	<	<	<	<	<	<0.5	<0.5
1,2-Dichloroethene	93.4	48.2	53.9	57.4	50.9	39.8	39.8	16.6	14.7	17.5	18.5	7.3	8.4	3.4
In 1,2-Dichloroethene	4.5	3.9	4.0	4.1	3.9	3.7	3.7	2.8	2.7	2.9	2.9	2.0	2.1	1.2
1,1-Dichloroethane				0.2	<	<	<	<	<	<	<	<	<0.2	<0.2
1,2-Dichloroethane	0.6	<	<	0.7	0.3	<	<	<	<	<	<	<	<0.2	<0.2
Trichloroethene	2.1	0.5	1.1	1.4	1.2	0.6	0.6	0.4	0.5	0.5	0.4	0.3	0.3	0.2
Methyl Isobutyl Ketone	<	<	<		<	<	<	<	<	<	<	<	<5.0	<5.0
Butyl Benzene	0.8	<	<		<	<	<	<	<	<	<	<	<0.5	<0.5
Vinyl Chloride	62.0	29.0	17.0	57.0	13.0	23.0	23.0	15.0	16.0	32.0	23.0	23.0	19	16
Sum BETX	4.4	6.8	1.2		2.5	1.5	1.5	0.5	0.4	4.6	3.1	10.5	<	0.2
Sum VOCs	180.9	98.8	77.2		76.5	68.6	68.6	33.6	31.6	59.2	45.0	41.1	27.7	19.8
Lead (Pb)	<	16.0	29.0	1.2	52.0	4.3	4.3	95.0	1.7	160.0	5.1	<1.0	<1.0	<1.0

TABLE 2
Arrowhead Remediation Site Analytical Discharge Data

Arrowhead Discharge in ug/l (parts per billion)					
	04/06/01	07/24/01	09/19/01	01/29/02	04/24/02
DRO (Diesel)	<80	<80	<80	<80	
GRO (Gasoline)	<40	<40	<40	<40	
Bromomethane	<0.5	<0.5	<0.5	<0.5	<0.5
Chloroethane	<0.5	<0.5	<0.5	<0.5	<0.5
Chloromethane	<0.5	<0.5	<0.5	<0.5	<0.5
Benzene	P<0.2	P<0.2	P<0.2	P<0.2	P<0.2
Ethylbenzene	<0.2	<0.2	<0.2	<0.2	<0.2
MTBE	<2.0	<2.0	<2.0	<2.0	<2.0
Naphthalene	<0.5	<0.5	<0.5	<0.5	<0.5
Toluene	<0.2	<0.2	<0.2	<0.2	<0.2
1,2,4-Trimethylbenzene	<0.5	<0.5	<0.5	<1.0	<0.5
1,3,5-Trimethylbenzene	<0.5	<0.5	<0.5	<1.0	<0.5
o-xylene	<0.2	<0.2	<1.0	<1.0	<1.0
p+m-xylene	<0.2	<0.2	<1.0	<1.0	<1.0
p-Isopropyltoluene	<0.5	<0.5	<0.5	<0.5	<0.5
n-Butylbenzene	<0.5	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethene	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dichloroethene	2.5	3.7	5.3	2.5	1.4
In 1,2-Dichloroethene	0.9	1.3	1.7	0.9	0.3
1,1-Dichloroethane	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-Dichloroethane	<0.2	<0.2	<0.2	P<0.2	<0.2
Trichloroethene	0.1	0.1	0.2	0.2	0.1
Methyl Isobutyl Ketone	<5.0	<5.0	<5.0	<5.0	<5.0
Butyl Benzene	<0.5	<0.5	<0.5	<0.5	<0.5
Vinyl Chloride	7.1	2.7	18	10	4.1
Sum BETX	P<0.2	P<0.2	ND	P<0.2	P<0.2
Sum VOCs	9.7	6.5	23.5	12.7	5.6
Lead (Pb)	5.8	39.0	4.4	2.9	14.0

Table 3
Arrowhead Refinery Natural Attenuation Data

Sampling Date	Units	MW-1A April-02	MW-1A Sep-02	MPCA-4A April-02	MPCA-4A July-02	MPCA-4A Sep-02	MPCA-4B April-02	MPCA-4B July-02	MPCA-4B Sep-02	MPCA-5A April-02	MPCA-5A July-02	MPCA-5A Sep-02
Ethane	ng/L	<5.0	5.5	41		NA	NA		190	<5.0		560/540
Ethene	ng/L	<5.0	6.2	230		NA	NA		120	<5.0		800/840
Methane	ugL	0.21	1500	2.2		NA	NA		200	0.42		90/84
Temperature	°C	6.21	8.04	4.12	11.07	NA	5.69	10.41	10.42	3.84	11.75	12.16
pH	S.U.	7.49	7.74	5.78	4.99	NA	6.68	6.06	7.36	7.01	7.29	7.01
Conductivity	uS/cm	315	360	3395	2516	NA	693	841	1136	476	487	524
Dissolved Oxygen	mg/L	NW	7.17	NW	1.76	NA	NW	2.23	2.02	NW	3.65	NW
Oxidation-Reduction Potential	mV	114.7	95.5	28.2	47.4	NA	-171.9	-66.3	50.1	4.7	18.3	183.5
Ammonia	mg/L	0.6-0.65	0.48	high		>3.6	ND		1.2/0.14(L)	0.84 - 0.91		1.2/0.07 (L)
Fe^{+2}	mg/L	ND - 0.4	0.1	10		9	2.9		4	ND - 0.4		ND - 0.1
H_2S	mg/L	ND	ND	0.08-0.09		ND	0.96 - 1.04		ND	ND to 0.01		ND
Mn, Dissolved	mg/L	0.22	0.17/<0.01(L)	NA		>0.7	>0.7		0.66/0.33(L)	Below scale		>0.7/3.4/3.4 (L)
CO_2	mg/L	73.8	6.4	Matrix Int.		ND	NA		15.8	144.4		18.4
SO_4	mg/L	15	22/18 (L)	>80		>80/230 (L)	>80		>80/430(L)	ND		6
Alkalinity(as $CaCO_3$)	mg/L	167	211/210 (L)	203		325/110 (L)	98		157/120 (L)	358		380.9
Turbidity	NTU	134	NA	82.5		75	104		NA	91.9		NA
Chloride	mg/L	20-80	65/49 (L)	Matrix Int.		56 (L)	15-60		40/32 (L)	10 - 40		20
Nitrite Nitrogen, Total	mg/L as N		<0.01 (L)			<0.01 (L)			<0.01 (L)			0.02 (L)
$NO_3 + NO_2$ Nitrogen	mg/L as N		NA						<0.05 (L)			<0.05 (L)
Dissolved Organic Carbon	mg/L		NA						8.5 (L)			8.9 (L)
Fe, Dissolved (Lab Analysis)	mg/L		0.41						8.2 (L)			0.066/0.084 (L)
Total Sulfide	mg/L		NA									

Notes:

(x) Holding Time Exceeded for MDH Laboratory Analysis

(L) MDH Laboratory Analysis

NW = Reading was obtained but oxygen probe not working correctly.

NA = Not Available.

ND = Not Detected.

Table 3
Arrowhead Refinery Natural Attenuation Data

Sampling Date	Units	MPCA-5B April-02	MPCA-5B July-02	MPCA-5B Sep-02	MW-14A April-02	MW-14A July-02	MW-14A Sep-02	MW-14B April-02	MW-14B July-02	MW-14B Sep-02	MW-14C April-02	MW-14C July-02	MW-14C Sep-02
Ethane	ng/L	480		370	<5.0		140	<5.0		24	<5.0		10
Ethene	ng/L	86		100	<5.0		820	<5.0		32	<5.0		9.2
Methane	ugL	490		310	1.0		610	0.12		120	0.4		370
Temperature	°C	6.12	8.57	9.77	6.42	9.38	10.13	6.22	10.45	9.56	7.23	9.22	8.04
pH	S.U.	6.18	6.46	6.55	7.47	6.43	7.46	8.31	7.63	7.83	8.26	7.96	8.56
Conductivity	uS/cm	1354	1569	1568	567	681	603	207	231	218	202	227	209
Dissolved Oxygen	mg/L	NW	1.41	1.91	NW	NW	NW	NW	NW	NW	NW	NW	2.16
Oxidation-Reduction Potential	mV	-74.2	-92.7	-56.7	24.4	41.7	155.4	19.2	-77	62.7	-69.3	48.8	119
Ammonia	mg/L	3.6 - 3.9		4.8/1.02 (L)	1.8		1.2/0.36 (L)	0.72-0.78		0.72/0.12 (L)	0.6-0.65		0.48
Fe^{+2}	mg/L	8.7		5	ND to 0.04		0.2	ND - 0.3		ND to 0.1	ND - 0.2		0.4
H_2S	mg/L	0.18		ND to 0.1	ND		NA	ND - 0.02		ND	ND to 0.01		NA
Mn, Dissolved	mg/L	>0.7		0.42/1.3 (L)	>0.7		0.7/0.88 (L)	0.28		0.24/0.19 (L)	0.08		0.12
CO_2	mg/L	Matrix Interference		>0.7	107.8		20.2	35.6		7.2	43		18.4
SO_4	mg/L	>80		>80/660 (L)	24		33/23 (L)	12		5/11 (L)	24		32.5
Alkalinity(as $CaCO_3$)	mg/L	506		710/620 (L)	349		275/410 (L)(x)	133		149/180 (L)	114		133
Turbidity	NTU	11.4		NA	48.8		NA	122		NA	7.3		NA
Chloride	mg/L	20 - 80		64/55 (L)	10-40		20/17 (L)	5 - 20		20/4.2 (L)	5 - 20		15
Nitrite Nitrogen, Total	mg/L as N			0.02 (L)			<0.01 (L)			<0.01 (L)			
$NO_3 + NO_2$ Nitrogen	mg/L as N			<0.05 (L)			<0.05 (L)			<0.05 (L)			
Dissolved Organic Carbon	mg/L			15 (L)			9.1 (L)			2.8 (L)			
Fe, Dissolved (Lab Analysis)	mg/L			47 (L)			0.089 (L)			0.27 (L)			
Total Sulfide	mg/L			<0.010 (L)						<0.10			

Notes:
(x) Holding Time Exceeded for MDH Labor
(L) MDH Laboratory Analysis
NW = Reading was obtained but oxygen pr
NA = Not Available.
ND = Not Detected.

Table 3
Arrowhead Refinery Natural Attenuation Data

	Units	Discharge	Discharge	Field Blank	Field Blank
Sampling Date		April-02	Sep-02	April-02	Sep-02
Ethane	ng/L	160	310	<5.0	
Ethene	ng/L	920	2500	25	
Methane	ugL	620	460	0.45	
Temperature	°C	NA	NA		
pH	S.U.	NA	NA		
Conductivity	uS/cm	NA	NA		
Dissolved Oxygen	mg/L	NA	NA		
Oxidation-Reduction Potential	mV	NA	NA		
Ammonia	mg/L	ND-0.3	2.64/0.12 (L)	0.84 - 0.91	
Fe^{+2}	mg/L	5.2	4.2	ND to 0.4	0.065
H_2S	mg/L	ND	0.65 - 0.148	ND to 0.01	
Mn, Dissolved	mg/L	1.4	>0.7/1.5 (L)	0.035	<0.01
CO_2	mg/L	139.2	24	12	
SO_4	mg/L	>80	>80/95 (L)	8	
Alkalinity(as $CaCO_3$)	mg/L	188	326/320 (L)		
Turbidity	NTU	14.6	NA	0.54	
Chloride	mg/L	80-320	300/280 (L)		
Nitrite Nitrogen, Total	mg/L as N		<0.01 (L)		
$NO_3 + NO_2$ Nitrogen	mg/L as N		<0.05 (L)		
Dissolved Organic Carbon	mg/L		5.2 (L)		
Fe, Dissolved (Lab Analysis)	mg/L	5.4	29 (L)		
Total Sulfide	mg/L		<0.10 (L)		
Notes:					
(x) Holding Time Exceeded for MDH Labor					
(L) MDH Laboratory Analysis					
NW = Reading was obtained but oxygen pr					
NA = Not Available.					
ND = Not Detected.					

TABLE 4
ARROWHEAD REFINERY SITE
NATURAL ATTENUATION SCREENING BASED ON EXISTING CONDITIONS

Analyte	Concentration in Most Contaminated Zone	Interpretation/Comments	Possible Points	UPGRAD. MW-1A	MPCA-4A	MPCA-4B	MPCA-5A	MPCA-5B	MW-14A	MW-14B	MW-14C	Discharge
Nitrate	<1 mg/L	May compete with reductive pathway at higher concentrations	2	NA	NA	2	2	2	2	2	NA	2
Manganese (II)	>1 mg/L	Anaerobic oxidation of cDCE possible	2	0	2	0	2	0	0	0	0	0
Iron (II)	>1 mg/L	Reductive pathway possible; anaerobic oxidation of vinyl chloride to CO2 possible	3	0	3	3	0	3	0	0	0	3
Sulfate	<20 mg/L	May compete with reductive pathway at higher concentrations	2	2	0	0	0	0	0	2	0	0
Sulfide	>1 mg/L	Reductive pathway possible	3	0	3	3	0	3	0	0	3	3
Methane	>0.01 mg/L	Ultimate reductive breakdown product	2			2	2	2	2	2	2	2
	>1 mg/L	Vinyl chloride accumulates	3	3								
	<1mg/L	Vinyl chloride oxidizes			0							
Oxidation Reduction Potential	<50 mVagainst Ag/AgCl	Reductive pathway possible	<50 mV=1 <-100 mV=2	0	1	1	1	1	1	1	1	NA
pH	5<pH<9	Tolerated range for reductive pathway										
DOC	>20 mg/L	Carbon and energy source; drives de-chlorination; can be natural or anthropogenic	2	NA	NA	0	0	0	0	0	NA	0
Temperature	>20°C	At T>20°C, chemical process can be accel-erated.	1	0	0	0	0	0	0	0	0	NA
Carbon Dioxide	>2x background	Ultimate oxidative breakdown product	1	0	0	0	0	NA	1	0	1	1
Alkalinity	>2x background	Results from interaction of carbon dioxide with aquifer minerals	1	0	0	0	1	1	1	0	0	0
Chloride	>2x background	Product of organic chlorine; compare chloride in plume to background concentrations	2	0	0	0	0	0	0	0	0	2
BTEX	>0.1 mg/L	Carbon and energy source; drives dechlorination	2	0	2	0	0	0	0	0	0	0
Dichloroethene		Product of TCE biodegradation	2	0	0	0	0	0	2	0	0	2
Vinyl Chloride		Product of dichloroethene biodegradation	2	0	0	0	0	0	2	0	0	2
Ethene/Ethane	<0.1 mg/L	Product of vinyl chloride biodegradation under reducing conditions	2	2	2	2	2	2	2	2	2	2
Chloroethane		Product of vinyl chloride biodegradation under reducing conditions	2	0	2	0	0	2	0	0	0	0
Ammonia as predominant form of N		Indicates reducing conditions		0	2	2	2	2	2	2	NA	2
TOTAL				7	17	14	12	18	15	11	9	21
EVIDENCE				LIMITED	ADEQUATE	LIMITED	LIMITED	ADEQUATE	ADEQUATE	LIMITED	LIMITED	STRONG
TYPE OF ENVIRONMENT				?	REDUCING	REDUCING	SOMEWHAT REDUCING?	REDUCING	SOMEWHAT REDUCING?	?	?	REDUCING
Score =	0 - 5	Inadequate evidence of biodegradation										
	6 - 14	Limited evidence of biodegradation										
	15 - 20	Adequate evidence of biodegradation										
	>20	Strong evidence of biodegradation										

TABLE 5
ALTERNATIVE COST ESTIMATES AND DISADVANTAGES

ALTERNATIVE	COMPONENTS	DISADVANTAGES	MPCA STAFF COSTS	PRESENT SAMPLING & MAINTENANCE COSTS*	REDUCED SAMPLING & MAINTENANCE COSTS	CAPITOL REMEDY SUPPLEMENTING COSTS	APPROXIMATE COST FOR TIME ESTIMATE
1	**STATUS QUO**						
	Continue to let natural attenuation proceed at its present rate.	Larger number of staff hours consumed. Slower cleanup.	Ave. is $15,000/yr.			$0	$272,000 to $544,000 (assumes 4- 8 years)
	Continue sampling but at a reduced rate			$44,605.51/year (Delta FY2002-2003 cost estimate	approx. $32,000/year (Delta)		
	Continue to operate the pump out system and discharge to WLSSD			$21,000/year (WLSSD + power)	$21,000/year (WLSSD + power)		
2	**FASTER ANAEROBIC DEGRADATION ALTERNATIVE**						
	Geoprobe Investigation	More MPCA staff time spent in next 2 years for reviews. Do not know if biodegradation rate would actually speed up. Need concrete examples that would work.	Ave. of $30,000/yr.			$25,000 total (geoprobe)	$307,000 (assumes 2 years)
	Design and Injected Heated Nutrient					approx. $130,000 (injecting heated nutrient)	
	Continued sampling but modify reduced sampling plan to fit the alternative				approx. $40,000/year (Delta)		
	Continue to operate the pump out system and discharge to WLSSD				$21,000/year (WLSSD + power)		
3	**AEROBIC DEGRADATION ALTERNATIVE**						
	Geoprobe Investigation	More MPCA staff time spent in next 2 years for reviews. Would involve changing an anaerobic system to an aerobic system. Air would have to aerate iron, manganese, and other metals to higher valence states. Possible fouling by iron and manganese. Strips vinyl chloride instead of allowing it to degrade biologically including from the soil matrix.	Ave. of $30,000/yr.			$25,000 total (geoprobe)	$337,000 (assumes 2 years)
	Design Air Sparging/SVE System						
	Implement Air Sparging/SVE System					130000 (SVE/air sparging)	
						O & M $15,000/year	
	Continued sampling but modify reduced sampling plan to fit the alternative				approx. $40,000/year (Delta)		
	Continue to operate the pump out system and discharge to WLSSD				$21,000/year (WLSSD + power)		

ATTACHMENT 7
ARROWHEAD REFINING CO. SUPERFUND SITE DRAFT RESTRICTIONS

Probable restrictions for the parcels on the Arrowhead Refinery Company site. These are a draft and may be edited, reduced, or increased.
Arrowhead Refining Co. Superfund Site Draft Restrictions

(a) The Property shall be used solely for industrial or restricted commercial purposes and shall never be used for purposes which may provide exposure routes for sensitive subpopulations including children, the elderly, the infirm, or others; such as but not limited to family housing, condominiums or apartments, schools, hospitals, nursing homes, day-care centers, playgrounds, recreation areas, or other similar purposes;

(b) No excavation shall be performed on the Property and no underground structures or basements shall be constructed on the Property (other than footings for above-ground structures and septic tanks) without MPCA approval.

(c) The french drain, sumps, pump house and instrumentation, piping from sumps to the pumphouse and from the pumphouse to the sanitary sewer line that parallels Highway 53, associated electrical connections, monitoring wells, and protective posts, and any future improvements to the remediation system shall not be disturbed in any manner;

(d) No connection shall be made to any utilities, including the sanitary sewer, electrical or telephone utilities, which are part of the Arrowhead Refinery site fixtures. The Owner shall obtain independent connections to utilities and not affect those utilities related to the remedial actions for the Arrowhead Refinery site; a portion of the drainage system installed for the cleanup is now owned and controlled by Western Lake Superior Sewer District. The sewer line was designed for the Arrowhead cleanup, so developers should not assume that connection to the line will be approved for other purposes. Consultation with WLSSD is essential prior to design and cost estimates for sewer connections.

(e) No change shall be made to the water table, surface water drainage, ditches, or infiltration to the water table in such a manner that may affect the ability of the site to be remediated or to remain protective;

(f) The Minnesota Department of Natural Resources and the U.S. Fish and Wildlife Service require, due to the remaining lead on site, that restoration of wetland, ponding, and water features that draw wildlife are not allowed.

(g) No wells and no drinking water wells shall be installed on the site.

(h) Compliance with the Consent Decree filed at the St. Louis County Recorder's Office is required to fulfill Consent Decree conditions, including the provision of access for MPCA to operate, maintain, improve, and remove remedial actions,

(i) Cooperation with the MPCA staff to complete the cleanup of the Site and conduct periodic future reviews is required; and

(j) No activity shall be permitted that adversely affects the protectiveness of the response actions at the Arrowhead Refinery site.